Monarch Tile, Inc.

Florence, Alabama

EE/CA Sampling and Analysis Plan

ENSR Consulting and Engineering

July 1994

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1.0

1.0 INTRODUCTION

Monarch Tile operates a tile manufacturing plant located at 834 Rickwood Road in Florence, Alabama (refer to Figure 1-1, Site Location and Topographic Map). The site includes two plants referred to as Plant No. 1, and Plant No. 2. The plants are separated by Rickwood Road with Plant No. 1 located north of Rickwood Road and Plant No 2 located south of Rickwood Road. The site has been in continuous operation since the mid 1950's. The site was previously leased and operated by the Stylon Corporation until 1973 when Stylon filed for bankruptcy. In September 1973, Monarch Tile leased and began operation of the facility.

Historical waste disposal practices are currently being investigated to determine the extent of impacts, if any, to surficial and subsurface soils at the site and surrounding vicinity. This Field Sampling and Analysis Plan (FSAP) addresses eight areas of historic waste disposal. These areas have been divided into two "operable units" consisting of areas potentially impacted by operations of Monarch Tile (Operable Unit No.1), and areas potentially impacted by previous owners and operators completely unassociated with Monarch Tile (Operable Unit No.2).

Operable Unit No. 1 consists of the areas within the Monarch Tile facility fence-line and the southern drainage ditch. The areas to be investigated include the small concrete settler north of Plant No. 1; the land disposal area on the northeastern portion of the facility; the wastewater basins south of Plant No. 2; the land disposal area south of the basins; and the south drainage ditch.

Operable Unit No. 2 consists of the north drainage ditch and the two fill areas located north and northeast of Plant No. 1.

This FSAP describes the scope of work, methods, and procedures to be used during an investigation into the five waste disposal areas of Operable Unit #1 at the Monarch Tile facility. Should EPA and Monarch Tile reach an agreement that Monarch Tile will also investigate Operable Unit No. 2, then this FSAP describes the scope of work to be used during the investigation of the three waste disposal areas in Operable Unit No. 2.

1.1 Drainage Ditches Discharge History

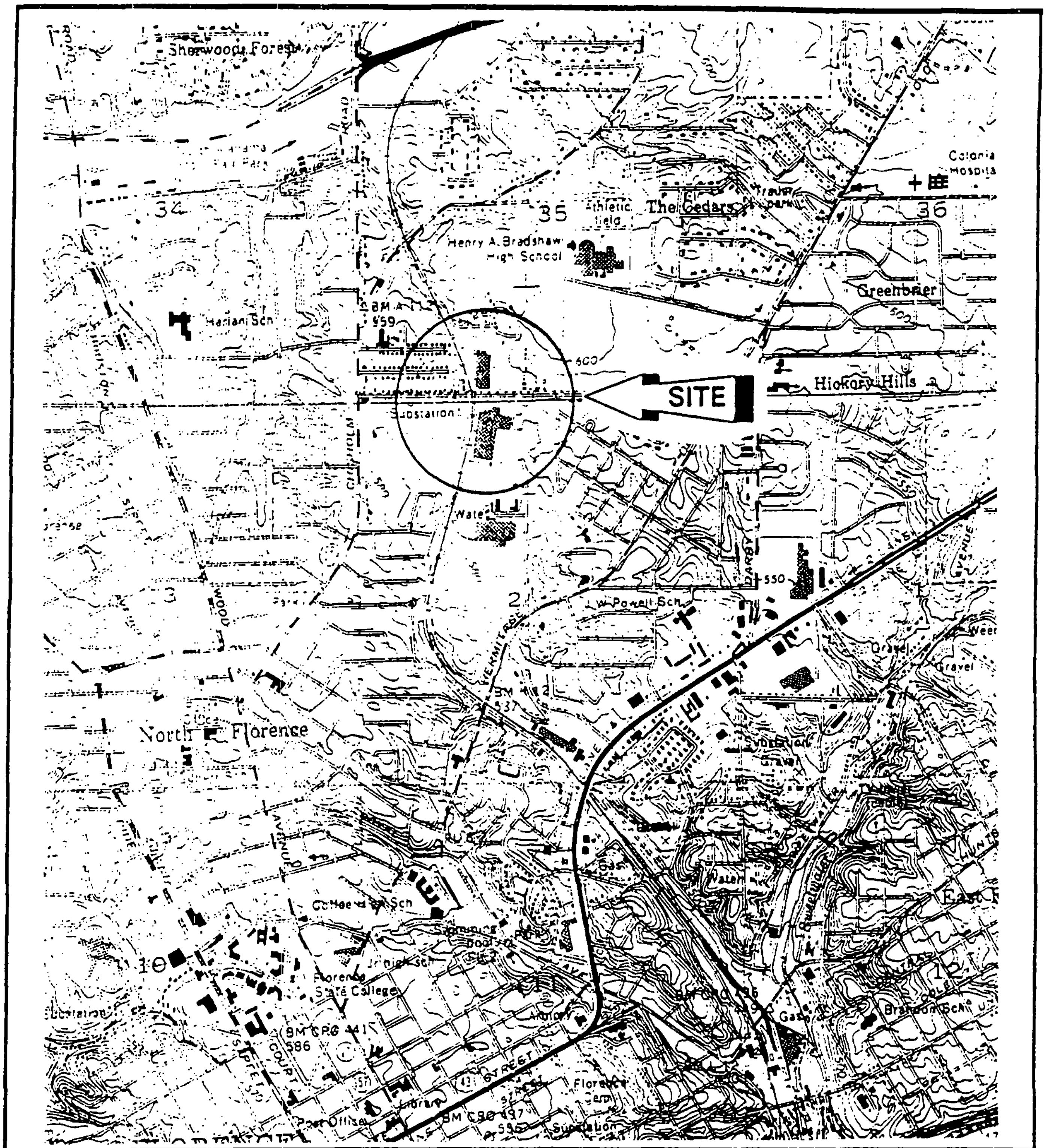
The Monarch Tile facility was previously operated by Stylon Corporation, from 1953 to 1973, for the manufacture of ceramic tile. Stylon discharged process wastewaters from Plant No. 1 through a small concrete settler to the North ditch from 1953 to 1960. Process wastewaters were discharged from Plant No. 2 through a wastewater basin (subsequently closed) and Basin #1 which then discharged to Basin #2. From 1956 to 1960, Basin #2 discharged to the ditch draining south from the facility, paralleling the Tennessee Southern Railroad. Refer to Figure 1-2, Site and Surrounding Vicinity Map.

In 1959, the closed basin had reached its storage capacity. The basin was taken out of service and filled with debris and clay soil. Native clay was compacted on the top of the closed basin. In 1960, process wastewaters from both Plant No. 1 and No. 2 were rerouted through a lime flocculation unit and clarifier installed behind Plant No. 2. The clarifier significantly reduced the quantity of suspended solids discharged to the south ditch. By rerouting process water from Plant No. 1, process water discharge to the north ditch was eliminated (some minor discharge of non-contact cooling water continued until 1992).

The process water was discharged from the clarifier to Basin #1, then to Basin #2, and into the southern draining ditch. The sludge produced by the clarifier was shipped to the Florence Sanitary Landfill. In 1973, Monarch Tile entered into a lease agreement with the City of Florence to operate the facility after Stylon Corporation went bankrupt. At the request of the Alabama Department of Environmental Management (ADEM) in 1976, Monarch Tile constructed Basin #3, obtained a State Indirect Discharge Permit, and routed the discharge from Basin #2 to the new basin which discharged directly to the municipal sewage system. Due to impending regulations, Monarch Tile changed its manufacturing process in 1979 to eliminate the use of lead silicate frits and barium carbonate. In 1980, the city landfill no longer accepted the sludge for disposal due to its high water content; therefore, Monarch Tile constructed the sludge trench to de-water and store the sludge. In 1988, Monarch Tile installed a rotary drum vacuum filter for de-watering the sludge and the de-watered sludge was then hauled to the City landfill for disposal.

1.2 Fill Areas

Beginning in 1956 and continuing until approximately 1969, two areas located northeast of Plant No. 1 were used for disposal of plant wastes. Monarch Tile did not participate in depositing waste in these areas which were created prior to Monarch Tile's operation of the facility. In addition, a third smaller area south of the lagoons at Plant No. 2 was filled. These areas are shown on the Figure 1-2 Site and Surrounding Vicinity Map. Materials deposited in these areas



SOURCE: USGS 7½ Minute Topographic Quadrangle.

SCALE

0 1/4 1/2 1 MILE

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FIGURE 1-1
SITE LOCATION AND TOPOGRAPHY MAP
Monarch Tile, Inc.
Florence, AL

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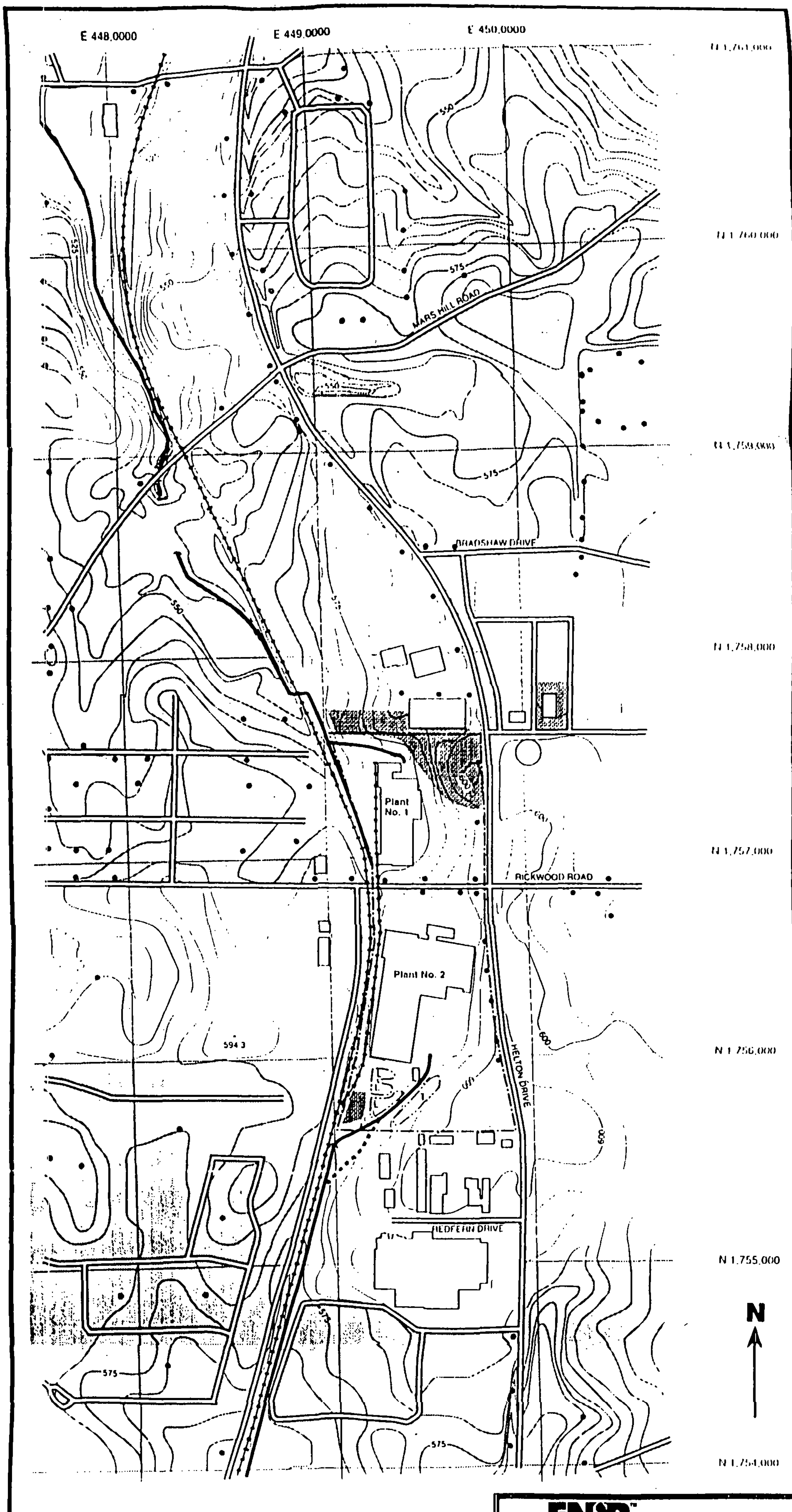

FIGURE 1-2
SITE AND SURROUNDING VICINITY MAP
MONARCH TILE, INC
FLORENCE, AL.

included broken and off specification tile product and small amounts of waste raw products (primarily clay body material).

The largest of the fill areas is located west of Helton Drive approximately 130 feet northeast of Plant No. 1. The fill area is irregular in shape and has approximate dimensions of 600 feet by 260 feet based on measurements from an aerial photograph dated January 29, 1967. The next largest fill area is located east of Helton Drive approximately 650 feet northeast of Plant No. 1. The fill area is rectangular in shape and has approximate dimensions of 210 by 155 feet based on the same 1967 aerial photograph. The third fill area located south of Plant No. 2 is irregular in shape and has approximate dimensions of 90 by 90 feet.

The two larger fill areas northeast of Plant No. 1 became inactive prior to the extension of Helton Drive to the north of Rickwood Road. Since then, two buildings have been constructed over the fill areas. The smaller of the two north fill areas has been almost completely covered by a commercial building. The larger of the fill areas has been partially covered by a warehouse building. The third fill area south of Plant No. 2 is uncovered.

1.3 Previous Site Investigations

Several site characterizations have been completed in the past by consultants to Monarch Tile, Inc. and by ADEM. These site characterizations are described in the following table.

TABLE 1-1

Past Site Investigations
Monarch Tile Facility, Florence, AL

Date of Investigation	Organization who conducted Investigation	Investigation Results
December 1987	Ecology and Environment, Inc.	A facility characterization was completed. Drainage channel samples contained barium, lead, and zinc, and cleanup was recommended. No other areas were recommended for remediation. Groundwater monitoring was completed and no metals were detected above the EPA's or ADEM's Maximum Contaminant Levels (MCLs) for drinking water from the five wells sampled.
October 1988	EPA	A preliminary assessment recommended a site inspection to be completed.

TABLE 1-1

Past Site Investigations
Monarch Tile Facility, Florence, AL

Date of Investigation	Organization who conducted Investigation	Investigation Results
January 1990	ADEM	A CERCLA site investigation was completed. This investigation summarized site topography, soils, geology, and hydrogeology. Groundwater monitoring was completed and no metals were detected above the EPA's or ADEM's MCLs for drinking water from the two wells sampled.
November 1990	ADEM	A site screening investigation was completed. Samples from the drainage channels (ditches) contained barium, lead, and zinc.
March 1992	ENSR Consulting and Engineering	Ditch characterization was completed. Grey deposits found in both the north and south drainage ditches contained significant concentrations of lead, barium, and zinc (total metals).
March 1992	ENSR Consulting and Engineering	Assessment of the waste water basins was completed. The closed basin, basin #1 and #2 contained lime sludges with elevated levels of total lead, barium, and zinc.
March 1994	ENSR Consulting and Engineering	Groundwater monitoring was completed. No metals were detected above the Environmental Protection Agency's (EPA's) or Alabama's MCLs for drinking water from the four wells sampled.
June 1994	ENSR Consulting and Engineering	Background Soils Study was completed. Statistical analyses of data collected from previous waste characterization analyses compared to background concentrations indicates that lead, barium, zinc, cadmium, nickel and silver are the only constituents of concern related to the site.
June 1994	ENSR Consulting and Engineering	Sampling and analysis of stormwater runoff was conducted in the North and South drainage ditches. Analytical results indicated that all metals were below EPA and ADEM MCLs for drinking water with the exception of two samples that were slightly above (a few ppbs).
July 1994	ENSR Consulting and Engineering	Boring, sampling, and analyses of soil samples was conducted within the land disposal area located on the northeast portion of Plant No. 1. Soil samples indicated that the surface soils and samples of the disposed material were below potential remediation goals. Metal concentrations in soils immediately below the waste material (and deeper) were within background ranges.

1.4 Previous Removal Action

During the Ditch Characterization conducted in 1992, ENSR discovered a grey material deposited in the north ditch up to 1,600 feet down-gradient of the Monarch Tile facility. The amount of material present in and along the ditch appears to have been influenced by hydraulic characteristics and the effects of storm event deposition and erosion.

ENSR removed a portion of this grey material to reduce any potential risk associated with its presence in the North ditch. While all exposed grey material was removed, there are some areas where grey material containing significant total lead and barium concentrations is still present within the side walls of the drainage ditch. ENSR placed gravel and rip rap along these sections in order to eliminate the potential for erosion and exposure of the grey material, thereby reducing the potential for environmental and human health impacts. Gravel and rip rap were also placed along sections of the ditch simply to reduce erosion in the intermittent drainage ditch.

Terra-First Inc. transported the excavated grey material and soil to Emelle on August 11, 1992, where the contaminated soil was stabilized and landfilled.

SECTION
2.0

2.0 OBJECTIVES

The objectives of this Monarch Tile Sampling and Analysis Plan are listed as follows:

Operable Unit No. 1

1) Determine the lateral extent of constituents associated with the wastewater discharge in soils adjacent to the south drainage ditch.

2) Obtain analytical data from surface soils near Monarch Tile's wastewater basins and settler, and the land disposal areas.

3) Install and sample additional groundwater monitoring wells to verify the results of previous studies which have indicated no impact to groundwater at the South Plant.

Operable Unit No. 2

4) Determine the lateral extent of constituents associated with the wastewater discharge in soils adjacent to the north drainage ditch.

5) Determine the metals concentrations in, and the depth and extent of fill in the two areas north and east of Plant No. 1

6) Determine whether soils beneath the fill material have been impacted by placement of the fill.

7) Install and sample groundwater monitoring wells at the North Plant and around the fill areas, if soil samples indicate associated impacts at depth.

Both Units

8) Conduct a comparison of the results of laboratory analyses to background concentrations of selected parameters established during the background sampling study.

9) Determine areas where lead concentrations are detected above background conditions which may require additional assessment and/or remediation.

SECTION

3.0

3.0 SCOPE OF WORK

3.1 Monarch Tile Surface Soil Sampling.

A Draft Public Health Assessment conducted by the Alabama Department of Health indicated that additional data should be collected concerning surface soils in areas adjacent to the waste generation areas (waste water discharge points, and settling ponds). In order to collect these data, a surface soils sampling effort will be conducted. The surface soil sampling will consist of grab samples at select locations and establishing two grids in the areas adjacent to the waste generation/accumulation areas in the two Operable Units and performing random sampling of the grids.

3.1.1 Operable Unit No. 1

The surface soil sampling grids will be established at the northeast end of Plant No. 1 in the fill area, and at the south end of Plant No. 2, and will include the lagoon areas, the fill area, and sludge trench area. Surface soil samples will also be collected from areas around the perimeter of the facility to ascertain if surface runoff from the site or onto the site has resulted in significant impacts. The location of the grids and surface sampling locations are shown on Figures 3-1 and 3-2.

The Plant No. 1 surface sampling grid will be approximately 400 by 250 feet with 50 x 50 foot grids each containing 2,500 square feet. A narrow of grid will also be established across the remaining 400 feet of northern border of Plant No. 1. The entire area will contain a total of 48 grids. The grids will be assigned an identification number which will be marked on stakes with an indelible marker. A random number generation table will then be used to select 20 grids for sampling. Grids that cannot be sampled due to the presence of structures will not be assigned a number.

The Plant No. 2 surface sampling grid will be approximately 600 feet by 300 feet with 50 by 50 foot grids each containing 2,500 square feet. The area will contain 72 grids. The grids will be assigned an identification number which will be marked on identification stakes with a permanent marker. A random number generation table will then be used to randomly select 20 grids for sampling. Grids which cannot be sampled because the entire grid is within the confines of a lagoon or other structures will not be assigned a number. The random number generation table is provide in Appendix A.

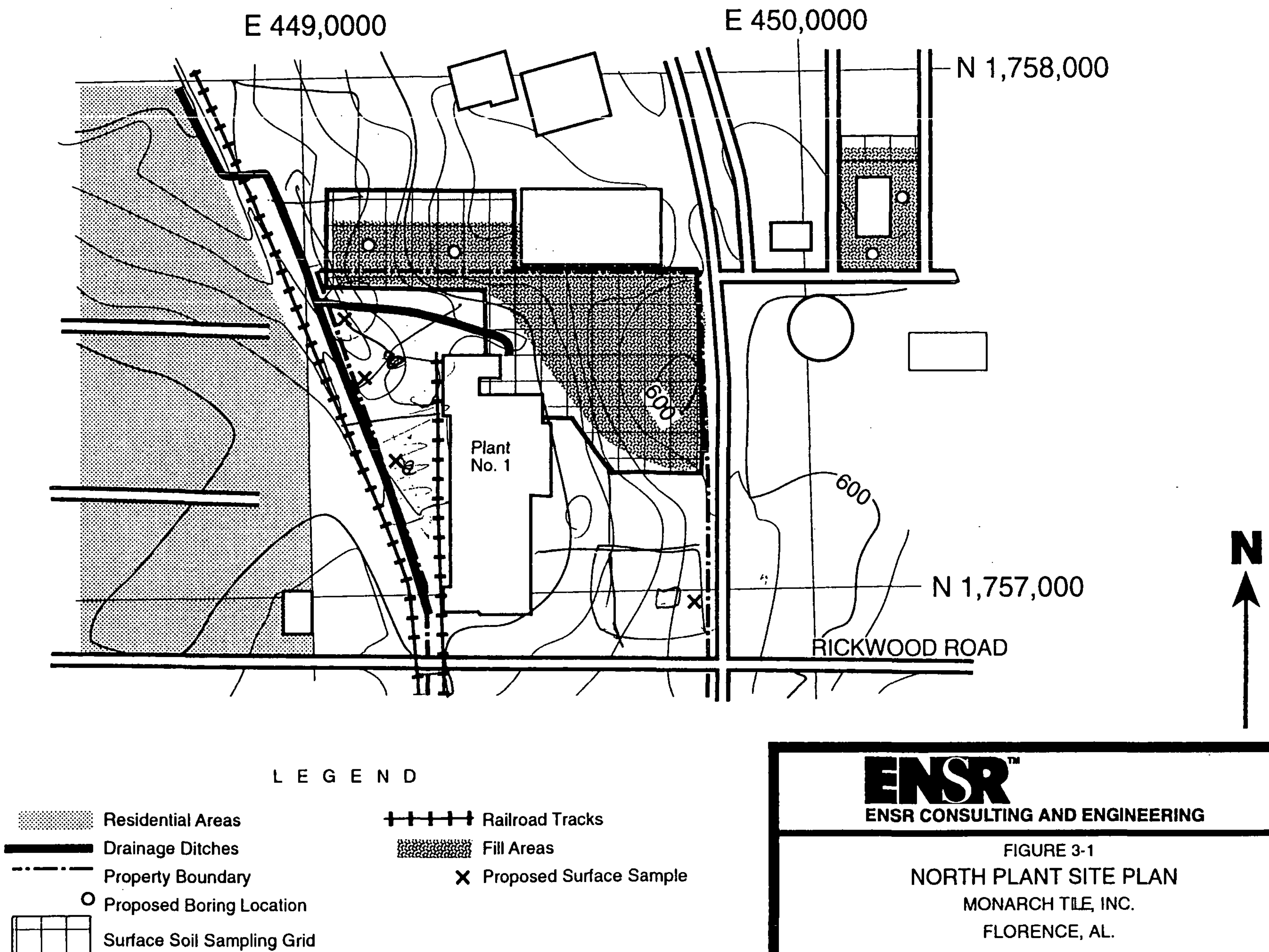

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FIGURE 3-1
NORTH PLANT SITE PLAN
MONARCH TILE, INC.
FLORENCE, AL.

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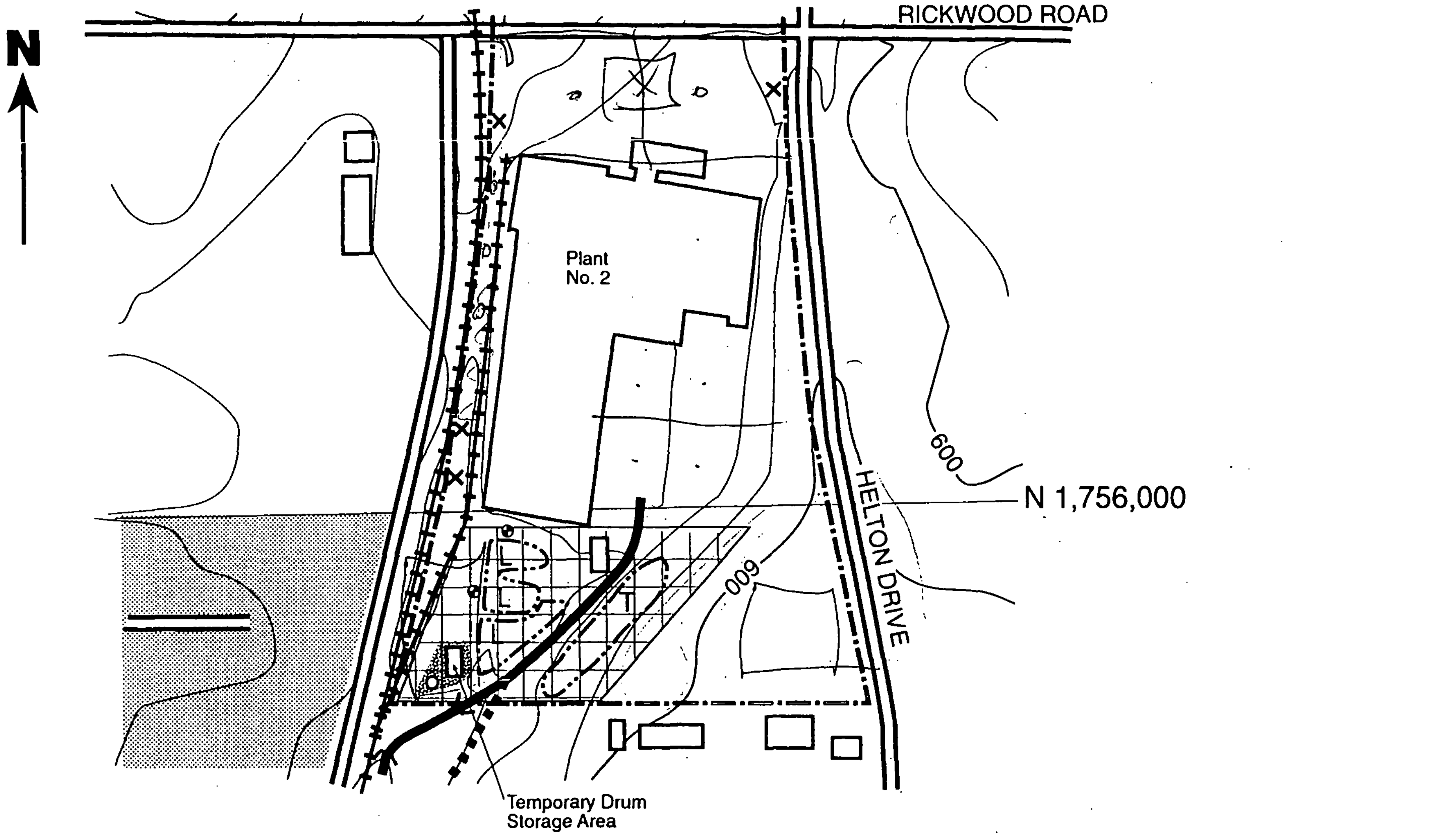

LEGEND

	Residential Areas	L	Lagoon
	Drainage Ditches	T	Sludge Trench
	Property Boundary		Railroad Tracks
O	Proposed Boring Location		Fill Areas
	Surface Soil Sampling Grig		Proposed Monitoring Well
		X	Proposed Surface Sample

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FIGURE 3-2
SOUTH PLANT SITE PLAN
MONARCH TILE, INC.
FLORENCE, AL.

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3.1.2 Operable Unit No. 2

A surface sampling grid will be established at the undeveloped fill areas to the north and northeast of Plant No. 1. The sampling grid established over the fill area immediately north of Plant No. 1 will be 150 feet by 400 feet with 50 by 50 foot grids each containing 2,500 square feet. The area will contain 24 grids. The sampling grid established over the fill area to the northeast of Plant No. 1 will be 50 feet by 150 feet with 50 by 50 foot grids each containing 2,500 square feet. The grid will contain 3 squares. The grids will be assigned an identification number which will be marked on identification stakes with a permanent marker. A random number generation table will then be used to randomly select 13 grids for sampling (all three grids will be sampled at the northeast fill location. Grids which cannot be sampled due to the presence of structures or improved surfaces will not be assigned a number. The random number generation table is provide in Appendix A.

3.1.3 Sample Collection and Analysis

A composite soil sample will be obtained for analysis from each selected grid. Samples will be collected with stainless steel sampling trowels from the top foot of soil from no fewer than four locations within the grid. The soil will be placed in a stainless steel bowl and then thoroughly homogenized with a mixing instrument prior to placement into a laboratory supplied container. The sample will be labelled, and recorded on a chain of custody. Sampling instruments and mixing equipment will be cleaned between samples in accordance with ENSR Standard Operating Procedures or SOPs. Sampling methods are presented in more detail in Section 4.0.

The soil samples will be tested for the total concentrations of 6 metals: barium, cadmium, lead, nickel, silver, and zinc, using approved EPA methods. Laboratory methods, containers, preservatives and holding times are outlined in Section 3.7.

3.2 Visual Drainage Ditch Screening

Previous studies have shown that soils impacted by historical releases of waste water can be visually identified. Impacted areas appear light grey in color which is indicative of the grey clay sized particles which have settled out of the waste water. Impacted areas have been identified ranging from relatively thick sequences of grey material greater than one foot in thickness to thin veneers a few centimeters in thickness. Tiles have been found associated with the grey material in areas of thicker accumulations, presumably the result of rapid water transport conditions resulting from heavy rain events or from dumping or regrading activities. Thin veneer accumulations may have resulted from low energy water transport and deposition, or as overbank deposits.

The drainages will be surveyed by a professional geologist experienced in fluvial systems. The survey will be conducted to identify environments of deposition within the fluvial system including but not limited to point bar areas, riffles, pools, thawlegs, natural levees, crevasse splays and primary flood plain deposits. The survey will be used to determine areas where increased screening and sampling scrutiny is warranted.

Since the impacted soil areas can be identified visually, the sampling strategy is designed to conduct a visual screening to identify obviously impacted areas followed by a sampling and laboratory analysis program to determine the concentrations of selected constituents. The visual screening will be conducted by traversing the drainage in a direction perpendicular to the flow direction exposing shallow soils for observation. The traverses will be spaced at 100 foot intervals for both drainages. The 100 foot interval will be measured from the center point of the drainage. Additional traverses may be necessary in areas where accumulations are likely, or in areas where likely accumulation areas are missed by an evenly spaced traverse pattern. Areas of likely accumulation which may require additional traverses will be identified by an experienced geologist.

Each traverse will begin outside of the drainage ditch on the west side in the primary flood plain (if present), and will proceed across the drainage ditch to the east and onto the opposite primary flood plain. Due to the low sinuosity of the drainages, the east and west banks are readily identifiable. Visual screening stations will be at established at 10 foot spacings along the traverse in areas outside of the drainage ditch. Inside of the drainage ditch, each bank will be screened in two places with one screening station located one third of the distance from the top of the bank, and the second station two-thirds of the distance from the top of the bank. A minimum of one station at the bottom of the drainage will also be visually inspected. Soils to a depth of approximately two feet will be visually screened at each station. Inspection will be conducted by excavating with a shovel or trowel to expose soils. Excavated soil will be returned to the excavation after the visual screening.

Each station will be marked with an orange survey flag. The drainage ditch, traverse number and the station number will be written on the flag. An overall sequence number will also be logged on the flag. For example, a flag marked S16-4-288 would indicate south drainage ditch, traverse number 16, station number 4, location 288, or the 288th visual screening location since the point of origin at the discharge point. Based on a 100 foot traverse interval, the sample would be located 1,600 feet downstream of the point of origin as measured in the center of the drainage.

Additional traverses other than on the 100 foot spaced interval will be identified with a capital letter followed by a distance from the last traverse. For example, S16A/10-5-294 would identify a traverse 10 feet downstream from traverse 16, station 5 and location 294.

The results of the visual inspections will be logged in a field book. The field book will indicate traverse number, station number, location number, whether visual evidence of contamination was noted, soil lithologic description, and other observations as appropriate. Additional location information such as distance to fixed points will also be recorded. Photographs of each sample location will be obtained, and recorded in a Photograph log.

Operable Unit No. 1

The south drainage ditch will be visually screened for 1,800 feet downstream from the discharge point. The south drainage ditch and traverse locations are shown on Figure 3-3.

Operable Unit No. 2

The north drainage ditch will be visually screened for 3,600 feet downstream from the discharge point. The north drainage ditch and traverse locations are shown on Figure 3-4.

3.3 Operable Unit No. 1, South Drainage Ditch Sampling Protocol.

All stations will be sampled and analyzed for total lead analyses by EPA Method 3050/6010. Samples will be collected from the selected stations by either surface soil or hand auger sampling procedures outlined in Sections 4.1 and 4.2.

A random number generation table will be used to select pre-collected samples for more extensive analyses. The visual location number will be used for the random number selection to determine these select locations. Approximately 8% of the samples collected for analysis will also be analyzed for barium, cadmium, nickel, lead, silver, and zinc in accordance with CLP - Level IV data requirements.

3.4 Operable Unit No. 2, North Drainage Ditch Sampling Protocol

All stations will be sampled and analyzed for total lead analyses by EPA Method 3050/6010. The samples will be collected from the selected stations by either surface soil or hand auger sampling procedures outlined in Sections 4.1 and 4.2.

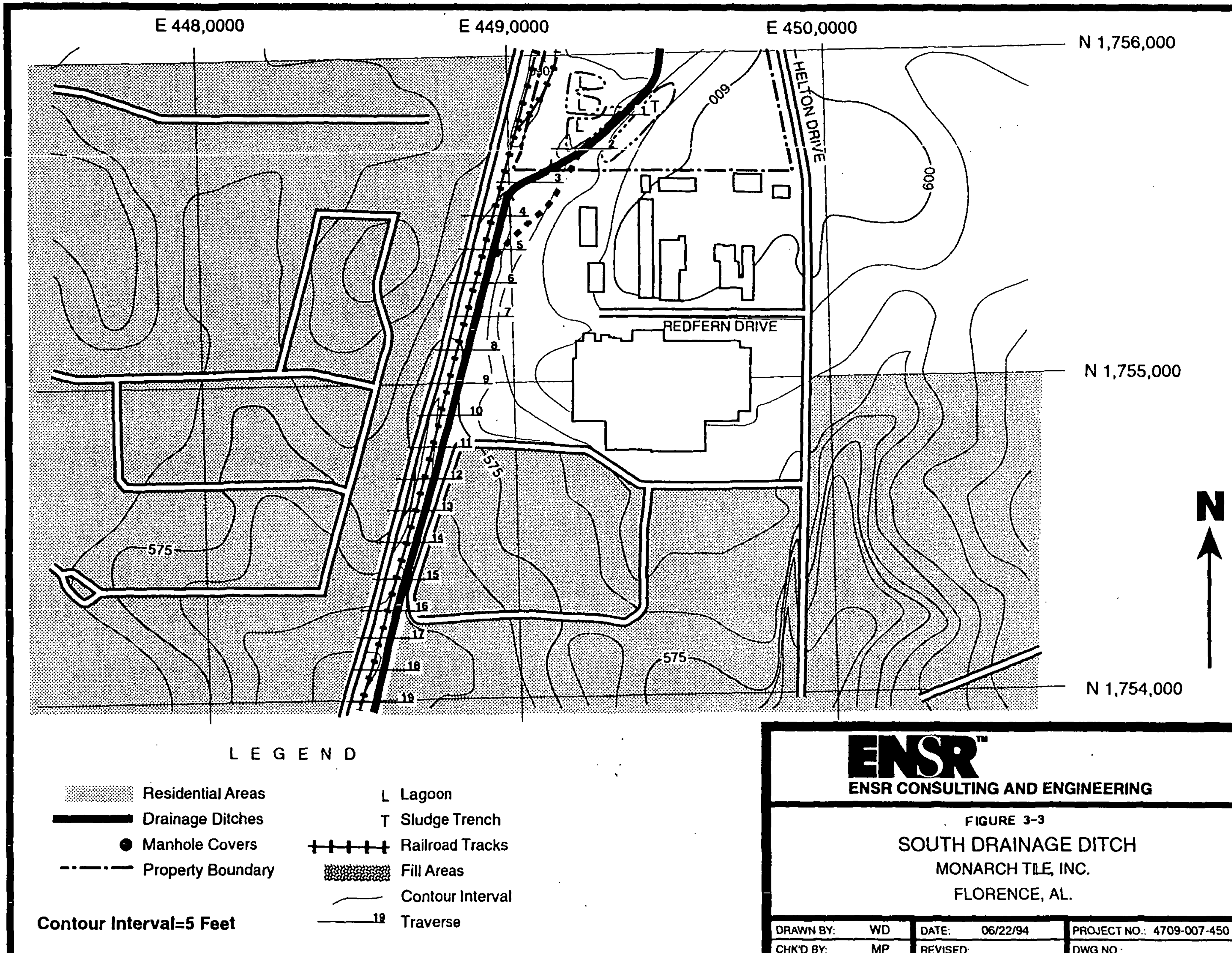
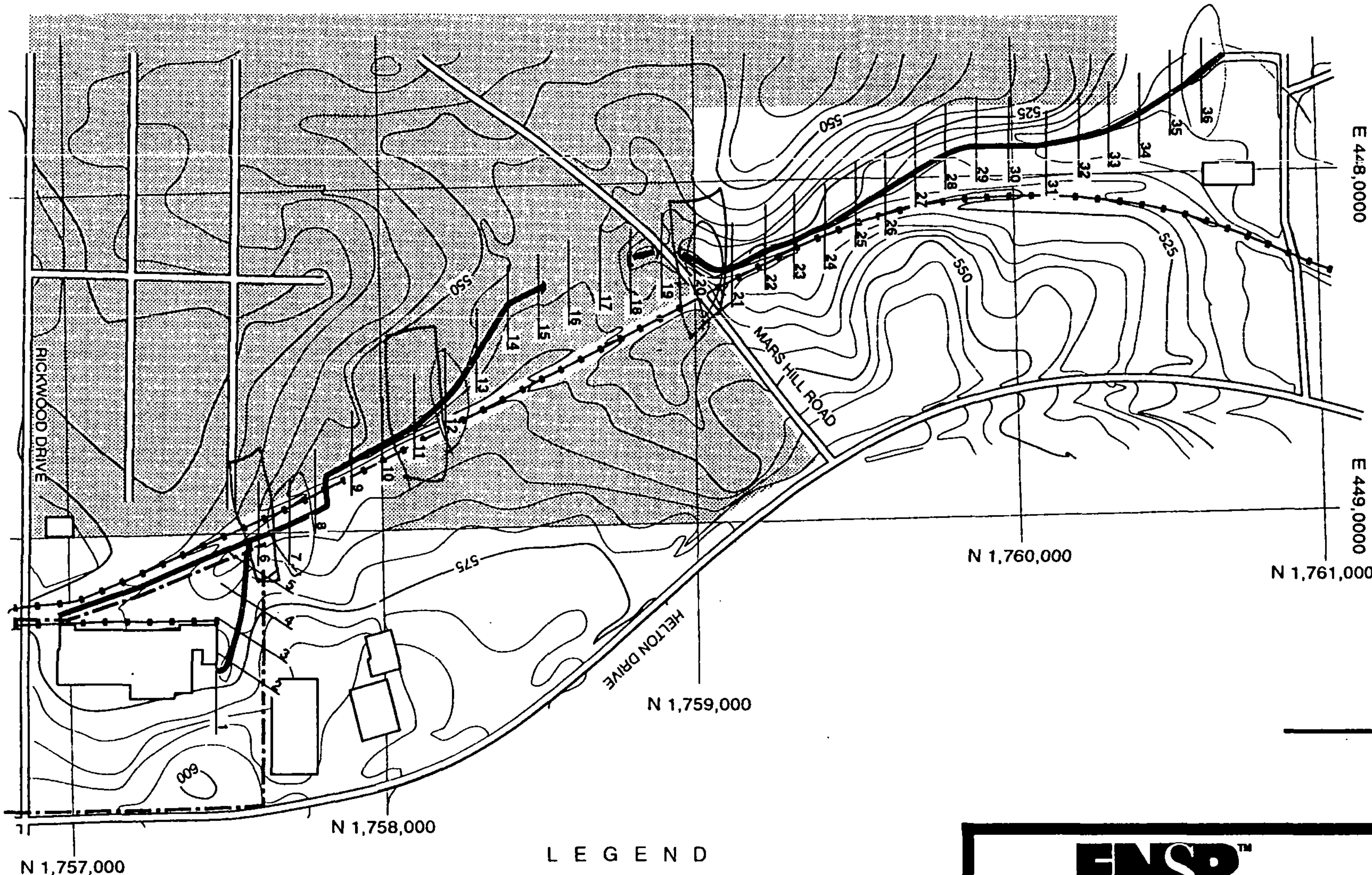


FIGURE 3-3
SOUTH DRAINAGE DITCH
MONARCH TILE, INC.
FLORENCE, AL.

3-8



LEGEND

Residential Areas	L Lagoon
Drainage Ditches	T Sludge Trench
Property Boundary	Railroad Tracks
	Fill Areas
	Contour Interval
	19 Traverse

Contour Interval=5 Feet

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FIGURE 3-4
NORTH DRAINAGE DITCH
MONARCH TILE, INC.
FLORENCE, AL.

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A random number generation table will be used to select pre-collected samples for more extensive analyses. The visual location number will be used for the random number selection to determine these select locations. Approximately 8% of the samples collected for analysis will also be analyzed for total concentrations of barium, cadmium, nickel, lead, silver, and zinc in accordance with CLP - Level IV data requirements.

3.5 Fill Area and Small Settler Investigation

An investigation shall be conducted to determine the potential for impact to native soils beneath fill material placed in area north and northeast of Plant No. 1 (Operable Unit No. 2) and the fill area south of the wastewater basins and adjacent to the small concrete settler north of Plant No. 1 (Operable Unit No. 1).

The investigation will include a series of borings through the fill areas into native soils beneath the fill. Soil sampling of native soils will be conducted and analyses performed in order to determine if soils have been impacted.

The borings will be advanced by hollow stem auger techniques. One of the borings in each fill area will be sampled continuously while the other borings will be sampled on five foot intervals utilizing split spoon methods. The borings will be examined by an experienced geologist and soil descriptions recorded on boring logs.

One composite sample will be obtained from the fill interval in each boring for analyses. Grab samples will be obtained from native soils at the fill/native soil interface, and at 5, 10, and 20 feet below the interface for analyses. Soil samples selected for laboratory analyses will be placed in laboratory supplied containers, labelled, listed on a chain of custody, packaged and shipped to the laboratory for analyses. Procedures for sample handling are presented in Section 4.6.

The samples will be tested for the total concentrations of barium, cadmium, lead, nickel, silver, and zinc with Level II reporting protocol. Approximately 8% of the samples will also be analyzed for the same six metals with Level IV reporting protocol. In addition, one native soil sample from each fill area will be tested for geotechnical parameters including the following: Atterburg limits, cation exchange capacity, permeability (falling head test), and grain size distribution.

More details, use EPA SOB Appendix B.8.3!

Section 4.3

Drilling and sampling equipment will be cleaned between borings and sample intervals by power washing, in accordance with ENSR SOP 7600, Appendix B. Decontamination water will be placed in dedicated 55-gallon drums, labeled, and placed in a temporary storage area established for all investigation derived waste (IDW). Once five drums of decontamination water have been collected, a composite sample consisting of equal volumes of water from each drum will be obtained and analyzed for the respective metals. Ultimate water disposal will be based upon the results of laboratory analyses.

Upon completion, the borings will be filled with a bentonite/cement grout. Soil cuttings will be placed in dedicated 55-gallon drums, labeled, and placed in a temporary storage area established for all IDW. Ultimate soil disposal will be based upon the results of laboratory analyses. investigation derived waste

3.5.1 Operable Unit No. 1

One boring will be advanced to a minimum depth of twenty feet below and adjacent to the concrete settler north of Plant No. 1. One boring will be advanced to a depth of twenty feet below the fill/native soil interface in the South Plant fill area. The proposed locations of the borings are provided on Figure 3-1, North Plant Site Plan and Figure 3-2, South Plant Site Plan.

3.5.2 Operable Unit No. 2

Two borings will be advanced to a depth of twenty feet below the fill/native soil interface in the larger fill area North of Plant No 1. Two borings will be advanced to the same depth in the smaller fill area Northeast of plant No. 1. The proposed locations of the borings are provided on Figure 3-1, North Plant Site Plan.

3.6 Groundwater Investigation

Do not agree with well Locations GW Direction W-SW not North West/West

In order to verify the results of previous groundwater investigations in the area of the lagoons at Plant No. 2, two additional monitoring wells will be installed and sampled. The locations of the proposed wells are shown on Figure 3-2. Boring and monitoring well installation, purging and sampling procedures are provided in Section 4.3 and in ENSR's SOPs presented in Appendix B.

After completion, the newly installed and five previously existing monitoring wells will be gauged, purged, and sampled. The elevations of the newly installed wells will be surveyed and the depths to water used to calculate the elevation of the groundwater table at the site. The data will be plotted and a potentiometric surface map prepared indicating the direction of groundwater flow at the site.

The water samples will be analyzed in the laboratory for the total concentrations of six metals: barium, cadmium, lead, nickel, silver, and zinc using Level II data protocol. Approximately 8% of the samples will also be analyzed for the same six metals with Level IV reporting protocol.

The results of the analyses will be compared to maximum contaminant levels (MCLs), to determine if constituents exceed drinking water standards.

3.7 Analytical Methods

Analytical methods for the surface soil, ditch, and fill area sampling are presented in the following table.

TABLE 3-1

Analytical Method Summary
Monarch Tile Soil Sampling

Chemical Constituent	EPA Procedure with Level II & Level IV Reporting	Estimated Detection Limit mg/kg	*Sample Container	Preservative	Holding Time
Silver	3050/6010	2.0	P, G - 4 oz	None	6 months
Barium	3050/6010	20	P, G - 4 oz	None	6 months
Cadmium	3050/6010	0.5	P, G - 4 oz	None	6 months
Lead	3050/6010	10	P, G - 4 oz	None	6 months
Nickel	3050/6010	4.0	P, G - 4 oz	None	6 months
Zinc	3050/6010	2.0	P, G - 4 oz	None	6 months

*Minimum size container.

Analytical methods for the groundwater, field blanks, and decontamination water sampling are presented in the following table.

TABLE 3-2

Analytical Method Summary
Monarch Tile Water Sampling

Chemical Constituent	EPA Procedure with Level II & Level IV Reporting	Estimated Detection Limit Ug/l	*Sample Container	Preservative	Holding Time
Silver	200.7	10.00	P, G - 8 oz	Nitric Acid	6 months
Barium	200.7	200	P, G - 8 oz	Nitric Acid	6 months
Cadmium	200.7	5.0	P, G - 8 oz	Nitric Acid	6 months
Lead	239.2	15	P, G - 8 oz	Nitric Acid	6 months
Nickel	200.7	40.00	P, G - 8 oz	Nitric Acid	6 months
Zinc	200.7	20	P, G - 8 oz	Nitric Acid	6 months

*Minimum size container.

SECTION 4.0

4.0 FIELD METHODS AND PROCEDURES

4.1 Surface Soil Sampling Procedures

Surface soil samples will be collected by stainless steel trowel procedures. The equipment will be decontaminated in accordance with ENSR Standard Operating Procedures (SOPs), included in Appendix B. Care will be taken to remove surface material not to be included in the sample, such as rocks, twigs, leaves, and other debris. The field supervisor (geologist and/or engineer) will maintain a log detailing the location and time of each sample as well as a lithological description. The procedure for surface soil sample collection is detailed in ENSR SOP 7110.

4.2 Hand Auger Soil Sampling Procedures

Hand auger soil samples will be collected during the sampling and analyses. A hand auger will be used to extract shallow soil samples up to five feet below the surface. Representative samples will be collected directly from the auger flight after it is withdrawn from the ground. The field supervisor will maintain a log detailing time and location of sampling as well as a description of the sample obtained. A steel tape will be used to measure the depth of all hand auger samples. Hand auger soil sample collection procedure is detailed in ENSR SOP 7110.

4.3 Soil Boring and Monitoring Well Installation and Sampling Procedures

Soil borings will be advanced using a truck mounted drilling rig with a hollow stem auger. Soil borings will be sampled at designated intervals utilizing split spoon sampling techniques advanced with a 140 pound hammer. Blow counts will be recorded indicating the number of blows required to drive the split spoon in six inch intervals. Soil samples will be visually classified and logged by an experienced geologist. Subsurface soil sampling procedures are detailed in ENSR SOP 7115, in Appendix B.

Groundwater monitoring well construction will be as follows: a two foot sediment trap will be placed at the bottom of the well, followed by 15 feet of 0.010 inch slotted 4 inch diameter schedule 40 PVC pipe, followed by blank 4 inch PVC to the ground surface. The annular space between the boring and the pipe will be filled with graded silica sand larger than 0.010 inch to a depth of two feet above the top of the screen; followed by a two foot bentonite pellet seal. The remainder of the annulus will be filled with a bentonite/cement grout to the ground surface. Surface completion will consist of either a locking steel shroud in a four foot square concrete pad with four 4" protective steel posts, or a flush mount watertight bolt-down manway cover capable of sustaining heavy traffic. The top of the well will have a slip on top cap for the shrouded wells, or a locking top cap for the flush mounted wells. Groundwater monitoring well construction is detailed in ENSR SOP 7220, in Appendix B.

After completion, the newly installed wells will be developed by removing copious amounts of water until the well is relatively free of sediment as determined by conductivity measurements. After the well is allowed to stabilize, the depth to water will be measured, and the well sampled for analyses. The well will be purged of a minimum of three saturated interval well volumes utilizing a clean purge bailer. After purging, the well will be sampled with a dedicated polyethylene disposable bailer. Well purging and sampling procedures are detailed in ENSR SOP 7221 and 7130, in Appendix B.

The well development and purge water will be discharged to the facility wastewater basins.

4.4 Equipment Decontamination

All sample collection apparatus will be fully decontaminated before sampling and between sampling events in accordance with ENSR SOP 7600 (Decontamination of Equipment) with the exception that methanol will not be used for gross contamination since this program does not address organics. Sampling and measurement equipment, including hand augers, and trowels will be decontaminated using the following sequence:

- Wash with non-phosphate detergent and tap water
- Rinse with tap water twice
- Rinse with distilled/deionized water

Drilling equipment will be washed with a steam cleaner between boring locations.

All decontamination water will be collected and placed in 55-gallon drums for temporary storage pending analytical results.

4.5 Sample Containers and Preservation

Sampling kits will be supplied by the laboratory. The sampling kits will be packaged in coolers and will include the appropriate sample containers. Decontamination deionized water will also be obtained from the laboratory. Table 3-1 summarizes sample volumes, container types, preservation requirements and holding times.

Once a sample has been collected, steps will be taken to preserve the chemical and physical integrity of the sample during transport and storage prior to analysis. Sample preservation will follow the procedures outlined in the analytical methods listed in Table 3-1.

4.6 Sample Packaging and Shipment

— Should meet DOT requirements

Following collection, samples will be packaged to prevent damage in accordance with ENSR SOP 7510 (Packaging and Shipment of Samples) in Appendix B. Samples will be hand-carried or shipped to the laboratory via overnight commercial carrier to ensure that sample holding times are met (Table 3-1).

4.7 Field Procedure Documentation

The procedures described below will be followed during sampling and analytical activities to provide sample documentation and chain-of-custody control during all transfers of samples.

4.7.1 Sample Location and Designation

The following format will be used in the field to designate sample names for the surface soil sampling effort. This naming scheme will differentiate samples by area, soil type, and number of sample collected in a specified area.

SS-1-2.5-D

where:	SS	=	Surface Soil
	1	=	Surface Soil Grid No.
	2.5	=	Depth of sample in feet
	D	=	Duplicate

The following format will be used in the field to designate sample names for soil samples collected from the drums of drill cuttings (if necessary). The naming scheme will differentiate samples by boring and drum.

MMDD-D5-B2

where:	MMDD	=	Month and Day
	D5	=	Drum No. 5
	B2	=	Boring No. 2 (T2,3,4=Traverses 2,3,4)

The following format will be used in the field to designate sample names for soil samples collected from the drainage ditches. The naming scheme will differentiate samples by drainage ditch, traverse, and station.

S22-4-1.5-D

where:	S or N	=	South or North Drainage Ditch
	22	=	Traverse Number
	4	=	Station Number
	1.5	=	Depth in 0.5 foot increments
	D	=	Duplicate

The following format will be used in the field to designate sample names for water samples collected from the groundwater monitoring wells, field decontamination water (field blanks), and waste decontamination water. The naming scheme will differentiate samples by date, sample type, and location.

MMDD-FB-ND

where:	MMDD	=	Month and Day
	FB	=	Field Blank (MW-1=Monitoring Well #1 & DW#2=Decontamination Water Drum #2)
	ND	=	North Ditch (SD=South Ditch, P1F=Plant No.1 Fill, etc.)
	D	=	Duplicate

4.7.2 Sample Logs

The field supervisor will be responsible for keeping a sample log to record information regarding each sample. The required information will include but is not limited to:

- Project number, site location
- Sample location description

- Sample identification
- Depth
- Soil classification
- Analysis requested
- Time, date, sampler name,
- Equipment used to collect the sample
- Laboratory designation

4.7.3 Field Log Book

Each sampling team will maintain a detailed log book, for recording information that is not recorded on sample log sheets or other documentation. All entries in this log will be accompanied by the signature of the author and the date of entry, the project name and number and the location. At the beginning of each sampling day, the designated team member will start the daily log by entering the date and time, the locations to be sampled, weather conditions, field team present and any potential problems. Other information to be entered into the field log book includes observations of field activity taking place, progress, and any problems, summary of equipment preparation procedures and a description of any equipment problems (including corrective action), reference to SOPs and explanations of any deviations from the work plan or SOPs.

4.7.4 Sample Labels

As samples are collected and containerized in the field, the following information will be recorded on each label:

- Project identification
- Project location
- Sample designation
- Data and time of sample collection
- Analyses to be performed
- Initials of the sample collector
- Depth of sample collected

A typical sample label is shown in Figure 5-1. Each sample will be identified as described in Section 5.6.1. All information necessary to identify each sample, and the corresponding sample code, will be recorded in the field notebook and sample log form. Sampling locations will be recorded on a map of the site.

After collection, preservation, and labeling, the sample will be maintained under the Chain-of-Custody (COC) procedures discussed below.

4.7.5 Chain-of-Custody Record

Chain of Custody procedures are intended to maintain and permanently document sample possession from the time of collection to disposal, in accordance with federal guidelines. A sample is considered to be under a person's custody if:

- It is in that person's possession
- It is in that person's view, after being in that person's possession
- It was in that person's possession and was locked up by them to prevent tampering
- It has been placed in a designated secure area by that person

The COC record will be initiated in the field for all samples collected. At a minimum, the following information shall be recorded on the form:

- Signature of custodian
- Date of receipt and relinquishment
- Sample location
- Sampling date and time
- Sample number
- Sample description (type and quantity)
- Analyses to be performed
- COC tape number
- Method of shipment and courier name(s) in the remarks box, if applicable

The initial custodian will: sign the COC record; enter the date, time, and COC seal numbers; tear off and file the back copy with the appropriate sampling log; and place the remainder in the shipping container with the samples. The sample documentation will be placed in a sealed plastic bag and taped to the inside lid of the cooler. Each cooler will be sealed with COC tape, which is signed and dated by the sample custodian.

The laboratory sample custodian will receive and sign the form for the laboratory, and record the date, time, and COC tape numbers. The laboratory log-in record will explicitly state the condition of the COC seal, any evidence of damage, whether the seal is air-tight, and the completeness of accompanying records. After inspection, each sample will be logged in and assigned a unique laboratory sample identification number. In addition, the following information will be entered in the logging system for each sample:

- Field sample identification number
- Laboratory sample identification number
- Date received
- Project name and number
- Collection date
- Sample type
- Condition of sample
- Analyses to be performed
- Assigned storage location

After sample log-in is complete, a copy of the COC record, with laboratory sample numbers and notations of any discrepancies, will be sent to the Project Manager (PM) to be entered into the project file. The original COC form will be filed in the laboratory with the shipper's waybill or airbill attached. Any problems or discrepancies will be reported immediately to the ENSR Field Supervisor and/or the Laboratory Analytical Coordinator.

4.8 Investigation Derived Waste (IDW)

All IDW that is containerized will be placed into dedicated 55-gallon drums. The drums will be labeled with the following information:

- Facility Name,
- Facility Contact,
- Type of Waste (Decontamination Water, Soil Cuttings, PPE, etc.),
- Specific Location or Area Where Waste was Generated (B-1=boring No.1, SD-South Ditch, etc),
- Date the Drum was Filled, and
- "AWAITING ANALYSIS".

All drums will be stored in a temporary storage area located as shown on Figure 3-2, South Plant Site Plan. The temporary storage area will be constructed to provide containment of the drums and temporary fencing to secure the area. Rain water that collects in the containment will be discharged to Monarch Tile's wastewater treatment system.

All IDW with potentially significant metals concentrations (according to the respective media Laboratory analyses) will be bulked, a waste determination made, and if the waste meets RCRA criteria, disposed of at a licensed TSDF within 90 days of accumulation. All other IDW, with the exception of personnel protective equipment (PPE), will be disposed of onsite in the sludge trench. Decontaminated PPE will be disposed of in an onsite dumpster to be handled with facility office waste.

SECTION
5.0

5.0 QUALITY ASSURANCE PROJECT PLAN

The purpose of this Quality Assurance Project Plan (QAPP) is to provide internal procedures of control and review so that results generated through combined field and laboratory efforts accurately fulfill the Data Quality Objectives (DQOs) established for the field portions of the FSAP. The DQOs ensure that the data will be gathered or developed in accordance with procedures appropriate for its intended use, and that data so gathered will be of known and documented quality so as to be able to withstand scientific and legal scrutiny.

5.1 Project Organization and Responsibility

The project organization is shown in Figure 5-1 Project Organization Chart. For additional information regarding the laboratory organizational structure, refer to Section 4.0, Organization and Responsibility, of the Comprehensive Quality Assurance Plan (CQAP) for American Environmental Network (AEN) submitted with this FSAP.

5.2 Quality Assurance Objectives

5.2.1 Data Quality Objectives

DQOs are qualitative and quantitative statements that specify the quality of the data required to support decisions made during characterization activities and are based on the end uses of the data to be collected. Data quality objectives are intended to allow the field and laboratory data to fulfill the objectives of the Sampling and analysis Plan as described in Section 2.0. This data use requires Level IV quality assurance/quality control (QA/QC) and data validation. The analytical level that address the data use and QA/QC effort is Contract Laboratory Program (CLP) Statement of Work for Inorganics (ILM1.0). Laboratory data will be validated as described in Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analyses.

ENSR will check the following parameters:

- Holding Times
- Custody
- Instrument Initial and Continuing Calibration Verification
- Laboratory Blanks, Duplicates and Spikes
- Field Duplicates and Blanks

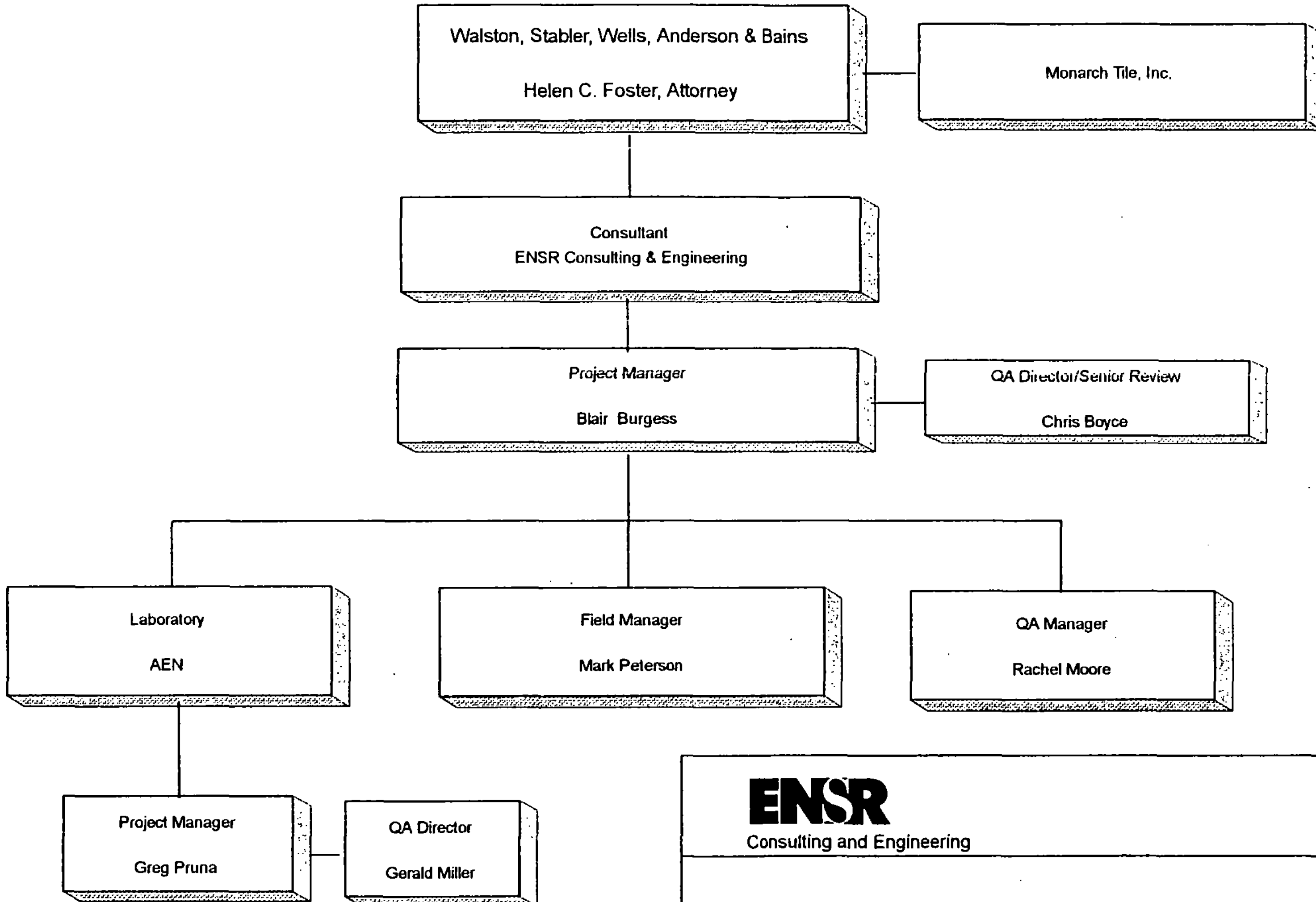

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FIGURE 5-1
PROJECT ORGANIZATION CHART
Field Sampling and Analysis Plan
Monarch Tile, Inc.
Florence, AL

DRAWN: SS	DATE: April 7, 1994	PROJECT NO.: 4709-007	REV: 1
FILE NO.: 4709007.pre	CHECKED: BB		

- Laboratory Control Sample Recoveries
- Standard Addition Results

5.2.2 Data Quality Criteria

The quality of a data set is measured by certain characteristics of the data, namely: Precision, Accuracy, Representativeness, Completeness and Comparability (PARCC). These parameters are discussed below:

5.2.2.1 Precision and Accuracy

Precision measures the agreement or repeatability of individual measurements of the same property using identical measurement methods. Accuracy (a measure of the bias in a system) is the degree of agreement of a measurement (or an average of measurements) with the accepted reference or true value.

For laboratory data, Refer to Section 11.1, Routine Methods to Assess Precision and Accuracy of AEN's CQAP.

Laboratory and field precision of duplicate results will be calculated as Relative Percent Difference (%RPD) using the following formula:

$$\mathbf{RPD = 200\ [(R_1 - R_{2)}/R_1 + R_2)]}$$

where:

R_1 = Analytical result; and
R_2 = Collocated and/or duplicate result

Laboratory accuracy will be calculated as Percent Recovery (%R) of an analyte spiked into field sample or laboratory blanks as follows:

$$\mathbf{Recovery\ (\%R) = 100\ (SSR - SR)/SA}$$

where:

SSR = Spiked Sample Result
SR = Sample Result
SAS = Spike Added

Laboratory precision and accuracy requirements and field precision requirements are listed in Table 5-1.

TABLE 5-1

Numerical Data Quality Objectives
Field Precision
Monarch Tile Soil Sampling

Method	Precision (%RPD)		Laboratory Accuracy (%R)	Completeness	
	Field	Laboratory		Laboratory	Overall
200.7 (water) 3050/6010 (soils)	25	20	90-110 (ICV) 90-110 (LCS) 80-120 (MS)	95% (water) 95% (soil)	90% (water) 90% (soil)
239.2 (water)	25	20	80-120 (ICV) 90-110 (LCS) 85-115 (MS)		

5.2.2.2 Representativeness

Representativeness describes the degree to which analytical data accurately and precisely define the population being measured. Several elements of the sampling and sample handling process must be controlled to maximize the representativeness of the analytical data (e.g., appropriate number of samples collected, physical state of the samples, site specific factors, sampling equipment, containers, sample preservation and storage, holding times, sample identity, and chain of custody (COC) procedures. The Sampling Program, Section 3.0 and the Field Methods and Procedures, Section 4.0 are designed to provide analytical data that are representative of the contamination existing on the site.

Representativeness of data is also affected by sampling techniques. Sampling techniques are described in the SOPs and summarized in Section 4.0.

5.2.2.3 Completeness

Completeness describes the amount of data generated that meets the objectives for precision, accuracy, and representativeness versus the amount of data expected to be obtained. For relatively clean, homogeneous matrices such as water, 95 percent completeness is expected. However, as matrix complexity and heterogeneity increase (such as with soil samples), completeness may decrease. The goal for completeness for soil samples is 90%. Where analysis is precluded or where DQOs are compromised, effects on the overall program must be considered. Whether or not any particular sample is critical to the program will be evaluated in terms of the sample location, the parameter in question, the intended data use, and the risk associated with the error.

5.2.2.4 Comparability

One of the objectives of the sampling effort is to provide analytical data that are characterized by a level of quality that is comparable between sampling points as well as with data collected previous and subsequent sampling efforts. By specifying the use of standard analytical procedures (e.g., CLP) and standard field sampling procedures (SOPs), the potential for variables to affect the final data quality have been effectively minimized. Analytical methods for the sampling event are outlined in Table 3.1.

5.3 Quality Control Samples

5.3.1 Laboratory Quality Control Samples

5.3.1.1 Blanks

Refer to Section 11.0, Quality Control Checks, of AEN's CQAP for a discussion on method and reagent blanks. Field or equipment decontamination rinsate blanks will also be used to ensure samples are not cross contaminated.

5.3.1.2 Spiked and Duplicate Samples

Spiked samples, including laboratory control spikes and matrix spikes are described in Section 11.0 of AEN's CQAP.

5.3.2 Field Quality Control Samples

5.3.2.1 Field Blanks

Field Blanks - One field blank (equipment blank) will be collected per day to assess the effectiveness of the equipment decontamination procedures. This sample will be collected from the fourth stage rinse water from the equipment decontamination process.

5.3.2.2 Field Duplicates

Field duplicate results are used to assess the combined field and laboratory precision. The results are anticipated to exhibit more variability than laboratory duplicates, which measure only laboratory precision. The field duplicate sample should be clearly designated on the COC form. Field duplicates will be replicate samples. Replicates are collected by mixing a double portion of the required volume of sample and dividing it into two sample containers. Field duplicate samples will be collected at a frequency of one per 10 samples or one per every day of field sampling, whichever is more frequent. Field duplicate results will be compared to assess sample homogeneity, handling, shipping, storage, preparation and analysis.

5.4 Laboratory Calibration Procedures

Calibration is required to ensure that the analytical system is operating correctly and functioning at the proper sensitivity to meet established detection limits. The analytical methodologies listed in Table 3-1 include specific instrument calibration procedures that will be followed by the laboratory. If an instrument has not been properly calibrated and the quality of the data has been adversely affected, the corrective actions outlined in Section 5.10 will be implemented. Refer to Section 9, Calibration, of AEN's CQAP for more information on the laboratories specific calibration schedules and procedures.

5.5 Analytical Procedures

The following is a description of the overall quality control program that will be incorporated into the analyses of samples associated with this project. General laboratory quality control procedures, such as balance calibration and maintenance and glassware cleaning are described in AEN's CQAP.

5.5.1 Sample Analysis

Selection of the analytical parameters of interest for each sampling site has been based on prior site activities and suspected or known contaminants.

All analytical procedures will be in accordance with the approved EPA-CLP methodologies. Specific quality control procedures will explicitly follow the approach defined in these methods.

5.5.2 Documentation

All analytical results will be thoroughly documented in reproduction quality. Duplicate records will be kept whenever practical. For each analytical result, including all blanks, spikes, calibration standards and samples; supporting documentation will be maintained that includes at least the following:

- Complete chain-of-custody records for the sample
- Records of traceability to Certified Reference Materials for all analytical standards, spikes, and balance calibration weights.
- Records of all sample preparation and analysis, including weights and volumes of samples, solvents, reagents, dilution ratios, standards, etc. These records should be in laboratory notebooks and/or on formalized data sheets, and should undergo review by a supervisor or quality control officer
- Documentation of all manual calculations in reproduction quality
- Copies of all calibrant calculations, plotted concentration calibration curves and computer derived quantitation reports
- The accompanying package of sample tracking records, analyst logbook pages, computer printouts, raw data summaries and instrument logbook pages.

5.6 Data Reduction, Validation, and Reporting

Analytical results will be validated as described in the Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analyses. Sample results which do not meet the criteria for precision, accuracy and completeness will be rejected. Refer to Section 12, Data management and Tables 5.1.1 and 5.1.2, Quality Assurance Objectives, of AEN's CQAP.

5.7 Internal Quality Control Checks

Refer to Section 11.0, Quality Control Checks, of AEN's CQAP.

5.8 Performance Audits

Refer to Section 14, Audits, of AEN's CQAP.

5.9 Preventative Maintenance

Refer to Section 10, Preventative Maintenance, of AEN's CQAP.

5.10 Corrective Action

ENSR will have the samples re-analyzed if they do not meet validation requirements (Section 5.6).

Refer to Section 13, QA Corrective Action Plan, of AEN's CQAP for laboratory corrective action.

5.11 Quality Assurance Reports

Refer to Section 15.0 Quality Assurance Reports, of AEN's CQAP. A data validation report will be completed by ENSR and included in the final draft. This data validation report will consist of a summary table with pass, fail, or comments for each of the data validation criteria listed in Section 5.2.2.

SECTION 6.0

6.0 REPORTING

6.1 Draft Report

ENSR will submit a preliminary report to Council for Monarch Tile, Inc. for review and comment. This report will contain the following information.

- Field procedures completed to collect all samples.
- Sample location maps.
- Analytical Results and Quality Control summary tables.
- Laboratory analytical reports.
- Comparison of Soil Results to Background levels.
- Comparison of Water Results to MCLs.
- Discussion of Fate Transport.
- Summary of the extent of impacts above previously established potential remediation goals.
- Conclusions and recommendations.

6.2 Final Report

After receipt of comments of the draft report, ENSR will prepare and submit seven copies of the final report to Council for Monarch Tile for distribution (five copies to EPA and two to ADEM).

APPENDIX A

Random Number Generation Table

8	2	5	7	3	4	1	1	1	4	6	4	1	1	8	8	2	1	2	8	9	3	3	1	2	5	3	6	5	3
0	4	7	5	0	4	9	7	4	4	8	4	8	8	4	7	9	0	1	1	5	9	7	5	1	4	8	3	4	6
6	4	7	4	8	1	4	3	3	5	1	5	5	2	5	4	6	4	2	0	7	2	2	4	4	6	5	7	1	6
3	7	2	6	7	6	4	5	4	5	2	4	8	8	5	6	4	3	2	5	7	9	8	7	3	6	7	8	9	1
4	6	3	5	6	4	4	2	7	6	4	1	5	3	3	8	6	7	9	3	1	8	8	8	1	9	2	8	2	1
2	7	5	2	6	9	1	8	9	2	0	4	5	6	2	3	7	4	1	5	4	6	1	7	4	9	6	9	8	8
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6	9	5	4	8	4	2	8	7	8	6	6	2	8	8	4	4	5	9	1	3	2	1	8	8	8	7	9	1	0
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3	8	1	8	1	6	0	7	3	6	4	9	7	2	5	9	0	8	0	7	2	3	8	7	1	4	6	1	2	2
7	2	7	2	2	1	6	6	8	2	9	3	1	4	1	4	6	5	2	5	1	9	8	5	9	2	3	4	9	6
6	2	2	7	4	5	9	0	6	5	3	3	3	0	4	3	6	1	6	6	8	1	5	6	6	8	8	4	6	7
8	5	9	0	9	1	4	7	6	7	1	5	1	4	9	7	0	2	5	4	5	4	5	4	1	5	9	1	1	8

APPENDIX B

ENSR Standard Operating Procedures

ENSR SOP 7110, "Surface Soil Sampling"

STANDARD OPERATING PROCEDURE

Title: Surface Soil Sampling

Date: 1st Qtr
Number: 7110
Revision: 1

1.0 General Applicability

This SOP describes the methods used for obtaining surface soil samples for physical analysis or quality/chemical analysis. This SOP also describes the procedures for using the various types of sampling equipment, which include shovels, trowels, and hand augers. The equipment may be constructed of special materials (for example, stainless steel, inert plactics) according to specific project requirements.

2.0 Equipment Descriptions:

2.1 shovel - long or short handle type. Used for penetrating the upper surface and/or obtaining soil samples directly.

2.2 trowel - basic garden variety, which resembles a small shovel. Constructed of steel or polypropylene (plastic)*. The blade of a trowel is generally flat and 5 to 6 inches in length. A scoop (blade has curved edges versus flat) may be substituted if necessary. Both can be purchased with volume calibrations.*

2.3 Hand auger - This tool consists basically of a short spiral-bladed metal rod (Auger) attached to a handle. Clockwise rotation of the T handle initiates the cutting process. Most of the loose soil is discharged upwards as the auger moves downwards. However, if the soil is cohesive some of it will stick to the auger flight providing a collectable sample at a measurable depth. Samples of surface soil can also be collected using a tube sampler which will be attached to the end of the auger rods and advanced into the soil to extract a sample.

3.0 Responsibilities

The project geologist/engineer will be responsible for the proper use and maintenance of all types of equipment used for obtaining surface soil samples; and the collection, labelling, handling and storage of all samples until further chain of custody procedures are undertaken.

4.0 Supporting Materials

- Sample containers/Labels
- Sample Logs/Boring Logs
- Decontamination materials (if required)*
- Field notebook
- Six-foot folding rule or tape measure for depth measurement

*Requirements for inert materials, decontamination, or calibrated sampling tools may be required depending upon the purpose of the sampling. These requirements will be detailed in a project-specific sampling plan.

0887J

STANDARD OPERATING PROCEDURE

Title: Surface Soil Sampling

Date: 1st Qtr
Number: 7110
Revision: 1

5.0 Method or Protocol

5.1 General Procedures

Specific sampling equipment and methodology will be dictated by the characteristics of the soil to be sampled, the type of soil samples required by the project and the analytical procedures to be employed. Soil samples obtained at the surface may be collected using a shovel or trowel. The type of analysis requested (e.g., grain-size distribution, physical, chemical) may require specific soil amounts or the use of specialized sampling equipment. Sampling to obtain uniform coverage within a specified area will require the use of an area grid. These considerations will be followed based upon specific project requirements defined in the project sampling plan.

A hand auger can be used to extract shallow soil samples up to three (3) feet below the surface. Representative samples will be collected directly from the auger flight as it is withdrawn from the ground, or from the tube sampler attached to the end of the rods and advanced into the soil.

The location of sample points will be determined on a project specific basis.

5.2 Standard Procedures

5.2.1 Select the specific sampling location. Construct a sampling grid if necessary. Remove all surface materials that are not to be included samples, for example, rocks, twigs, leaves.

5.2.2 Select type of sampler required to obtain the correct sample. At the surface, use a shovel, trowel or tube sampler; below surface, use a hand auger or tube sampler.

5.2.3 Obtain a sufficient quantity of soil for the desired chemical or physical analyses.

5.2.4 When using the hand auger, auger the hole to the required depth, then slowly remove the auger and collect the soil sample from the auger flight itself at the point corresponding to the required depth. Reinsert and continue augering if deeper samples are required. In addition, a tube sampler can be attached to the auger rods after augering to the desired depth, inserted into the open bore, and then advanced into the deposits at the base of the boring. If sampling is needed in sandy or non-cohesive soil, a shovel may be necessary to obtain samples.

If sequential depths - Change auger bucket at each collection point. The bucket can be used to get to the next sampling depth but a "clean" bucket should be used to collect the sample

Put sample into mixing pan or bowl - Homogenize the sample then put into container.

5.2.5 Cap the sample container; attach label; seal container (if analysis for volatile chemical species is anticipated). Record all observations such as visual soil description in a field book or on a surface soil sample log. Complete chain of custody records. Utilize proper storage procedures (see SOP 7510).

5.2.6 Decontaminate the sampler between collection points. Decontamination procedures will be performed as identified in SOP 7600 Decontamination unless otherwise specified.

5.2.7 Initiate proper procedures for delivery of the samples to the designated laboratory. This includes packaging, and shipping with chain of custody forms (see SOP 7510).

6.0 Documentation

Various forms are required to ensure that adequate documentation is made of the sample collection activities. These forms include:

- field log books
- sample logs
- chain of custody forms
- shipping forms

The field book will be maintained as an overall log of all samples collected throughout the study. These documents will be retained in the appropriate project files.

SURFACE SOIL SAMPLE LOG

PROJECT NO. ____________________ PROJECT LOCATION ____________________

SAMPLE POINT NO. ____________________

DATE ____________________ TIME ____________________

SAMPLE POINT DESCRIPTION/DESIGNATION ____________________

____

SAMPLE COLLECTION:

EQUIPMENT USED ____________________

NO. OF SAMPLES COLLECTED __________ CONTAINER SIZE __________

SAMPLE NO.	DEPTH	TYPE OF MATERIAL	ANALYSIS REQUEST
______	______	______	______
______	______	______	______
______	______	______	______
______	______	______	______
______	______	______	______

COMMENTS ____________________

____

____

LAB DESIGNATION ____________________

SHIPPING BOX NO. ____________________

COLLECTOR'S NAME ____________________

0887J

1.0 General Applicability

This SOP describes the methods used in obtaining subsurface soil samples for identification of soil grain-size distributions, stratigraphic correlations, and chemical analysis (if required). Subsurface soil samples are obtained in conjunction with soil boring and monitoring-well installation programs and provide direct information as to the physical makeup of the subsurface environment. This SOP covers subsurface soil sampling by split-spoon only, as this is the means most often used for obtaining samples from unconsolidated deposits. (See also, SOP 7220 - Monitoring Well Construction).

2.0 Responsibilities

It shall be the responsibility of the contract driller to provide the necessary materials for obtaining subsurface soil samples. This includes the split-spoon sampler and sample containers (sized according to project requirements) as well as the appropriate boring logs. It is the contract driller's responsibility to maintain a complete set of boring logs for the record. Standard Penetration Tests (SPT) (ASTM: 1586-67) will be conducted by the contract driller if required by the project. Equipment decontamination shall also be the responsibility of the driller.

It shall be the responsibility of the project geologist/engineer to observe all activities pertaining to subsurface soil sampling to ensure that all the standard procedures are followed properly, and to record all pertinent data on a boring log. It is also the geologist/engineer's responsibility to indicate to the contract driller at what specific depth samples shall be collected. The geologist/engineer will maintain custody of all samples until they are shipped or delivered to their appropriate destination.

3.0 Supporting Materials

In addition to those materials provided by the contract driller, the geologist/engineer will provide:

- sample bottles and labels
- boring logs
- field notebook
- chain-of-custody forms and tape

4.0 Methods or Protocol for Use

4.1 General Procedures

The sampling depth interval is typically one (1) sample per every five (5) vertical feet with additional samples taken, at the discretion of the project geologist/engineer, when significant textural, visual or odor changes are encountered.

The following are the standard procedures to be used in advancing casing and obtaining soil samples.

Specific requirements described in a project's task plan may call for deviations in the standard procedures but these will be taken into account on a project by project basis. Any deviations from specified procedures will be recorded on the boring log or into a field notebook.

4.2 Standard Procedures - Advancing Casing

4.2.1 The casing shall be advanced to the required depth. All loose material within the casing shall be removed prior to sampling. The casing shall be advanced according to project requirements. Borings are typically advanced by two methods, drive-and-wash casing, and hollow-stem augering. The casing shall be of the flush joint or flush couple type and of sufficient size to allow for soil sampling, coring, and/or well installation. All casing sections shall be straight and free of any obstructions. Hollow-stem augers or solid flight augers with casing may be used according to specific project requirements as described in the project task plan. If hollow-stem augers are to be used, the bit shall be equipped with a plug device to be removed at the required sampling depth.

That will not interfere with the analysis - i.e. - PINE is not a good choice, not is pressure treated.

4.2.2 For those borings which encounter obstructions, the casing shall be advanced either past or through the obstruction by drilling, mechanically fracturing, or blasting (if required). If the obstruction is bedrock, a rock core shall be taken according to project requirements and following the standard procedures for rock coring (SOP # 7210).

4.2.3 The use of recirculated water shall not be permitted when casing is being driven, unless specified in the project task plan, directed and properly documented (in field notebook, logs) by the geologist/engineer.

4.2.4 If recirculated water is used all loose material within the casing shall be removed by washing to the required sampling depth using a minimum amount of water. Care shall be taken to limit recirculation of the wash water to those times when the water supply is extremely limited or unavailable.

4.3 Standard Procedures - Soil Sampling

4.3.1 Subsurface soil samples shall be obtained using a split-tube type sampler (split spoon) having a 2-inch O.D. with a corresponding 1 3/8-inch I.D. and a 18- or 24-inch long sample capacity. It shall be equipped with a ball check valve and may require a flap valve or basket-type retainer for loose-soil sampling. Sampling frequency will be as stated in Section 4.1, or as otherwise specified in the project task plan.

4.3.2 Sampling depth shall be independently determined by the inspecting geologist, and any discrepancies shall be resolved prior to obtaining the sample.

4.3.3 Samples shall be obtained using the standard penetration test (SPT), which allows for determination of resistance within the deposits. The sampler shall be driven using a 140-pound hammer with a vertical drop of 30-inches using 1 to 2 turns of the rope on the cathead. A certificate indicating exact weight may be required for documentation purposes. The number of hammer blows required for every 6 inches of penetration shall be recorded on the boring log.

4.3.4 The sampler shall be immediately opened upon removal from the casing. If the recovery is inadequate, another attempt shall be made before drilling progresses. Adequate recovery should be no less than 12 inches, not including any residual wash material brought up with the sample.

4.3.5 The sample shall be split if necessary, placed in the appropriate container, labelled, and placed in the storage box. The boring log and the sample container/label should contain the following information for each sample: site name, boring location, depth, blow counts, recovery, sample number and collection date. The type of material shall be indicated in the boring logs and will be described using the Unified Soil Classification System (ASTM: D2487-69 and D2488-69).

Mixing

4.3.6 The sampler shall be cleaned with water between attempts in order to prevent cross-contamination. If further decontamination is required, SOP 7600 shall be consulted.

4.3.7 Proper procedures for delivery to the designated laboratory shall be initiated when all samples are collected. This includes packaging, shipping with sample logs, analysis request forms, and chain of custody forms.

5.0 Documentation

Various forms are required to ensure that adequate documentation of each sample is followed and will include:

- sample logs
- boring logs
- chain of custody forms
- shipping forms

In addition, a field log book will be kept as an overall log of all samples collected throughout the study. All documents are retained in the appropriate project files idefinitely. It is important that all field documentation be as complete as possible to ensure traceability (QA/QC requirements).

Project ______ Site ______ BORING ______ Sh 1 of ____
Date Started ______ Completed ______ Ground Elevation ______
Total Depth ______ Location ______ Logged by ______
Casing I.D. ______ Contractor ______
Remarks ______

Elev. Feet	Depth Feet	Sample: Type & Number	Sample: Blows per 6 In.	Sample: Depth Range	Sample: Rec.	Graphic Log	Sample Description	Equipment Installed

ENSR

Title: Ground-Water Sample Collection from Monitoring Wells

1.0 Applicability

This Standard Operating Procedure (SOP) is concerned with the collection of valid and representative samples from ground-water monitoring wells. The scope of this document is limited to field operations and protocols applicable during ground-water sample collection.

2.0 Responsibilities

The site coordinator or his delegate will have the responsibility to oversee and ensure that all ground-water sampling is performed in accordance with the project-specific sampling program and this SOP. In addition, the site coordinator must ensure that all field workers are fully apprised of this SOP. The field team is responsible for proper sample handling as specified in SOP 7510, Handling and Storage of Samples.

3.0 Supporting Materials

The list below identifies the types of equipment which may be used for a range of ground water-sampling applications. From this list, a project-specific equipment list will be selected based upon project objectives, the depth to ground-water, purge volumes, analytical parameters and well construction. The types of sampling equipment are as follows:

- Purging/Sample Collection

  Bailers
  Centrifugal Pump
  Submersible Pump
  Peristaltic Pump

- Sample Preparation/Field Measurement

  pH Meter
  Specific Conductance Meter
  Filtration Apparatus
  ~~Water-Level Measurement~~ Equipment

Additional equipment to support sample collection and provide baseline worker safety will be required to some extent for each sampling task. The additional materials are separated into two primary groups: general equipment which is reusable for several samplings, and materials which are expendable.

- General

  Project-specific sampling program
  Deionized-water dispenser bottle
  Methanol-dispenser bottle
  Site-specific Health & Safety equipment (gloves, respirators, goggles)
  Field data sheets and/or log book
  Preservation solutions
  Sample containers
  Buckets and intermediate containers
  Coolers
  First-Aid kit

- Expendable Materials

  Bailer Cord
  Respirator Cartridges
  Gloves
  Water Filters
  Chemical-free paper towels
  Plastic sheets

Equipment checklists have been developed to aid in field trip organization and should be used in preparation for each trip.

4.0 Water-Level Measurement

4.1 Introduction

Prior to obtaining a water-level measurement, cut a slit in one side of the plastic sheet and slip it over and around the well, creating a clean surface onto which the sampling equipment can be positioned. This clean working area should be a minimum of eight feet square. Care will be taken not to kick, transfer, drop, or in any way let soil or other materials fall onto this sheet unless it comes from inside the well. Do not place meters, tools, equipment, etc. on the sheet unless they have been cleaned first with a clean rag.

Where do you stand?

After unlocking and/or opening a monitoring well, the first task will be to obtain a water-level measurement. Water-level measurements will be made using an electronic or mechanical device. Electronic measurement devices will be used in all wells wherein a clearly audible sound cannot be produced with a mechanical device.

4.2 Well Security

Unlock and/or open the monitoring well. Enter a description of condition of the security system and protective casing on the Ground-Water Sample Collection Record shown in Figure 1.

4.3 Measuring Point

Check for the measuring point for the well. The measuring point location should be clearly marked on the outermost casing or identified in previous sample collection records. If no measuring point can be determined, a measuring point should be established. Typically the top (highest point) of the protective or outermost well casing will be used as the measuring point. The measuring point location should be described on the Ground-Water Sample Collection Record and should be the same point used for all subsequent sampling efforts.

4.4. Measurement

To obtain a water-level measurement lower a clean steel, fiberglass tape into the monitoring well. Care must be taken to assure that the water-level measurement device hangs freely in the monitoring well and is not adhering to the wall of the well casing. The water-level measuring tape will be lowered into the well until the audible sound of the unit is detected or the light on an electronic sounder illuminates. At this time the precise measurement should be determined (to hundredth of a foot) by repeatedly raising and lowering the tape to converge on the exact measurement. The water-level measurement should be entered on the Ground-Water Sample Collection Record. As well point of measurement should be indicated; i.e., top of protective casing, top of pueriser, ground level.

4.5 Decontamination

The measurement device shall be decontaminated immediately after use with a methanol soaked towel. Generally only that portion of the tape which enters the water table should be cleaned. It is important that the measuring tape is never placed directly on the ground surface.

5.0 Purge-Volume Computation

All monitoring wells to be purged prior to sample collection. Depending upon the ease of purging, 3 to 10 volumes of ground water to be determined by hydrogeologing prior to sampling present in a well shall be withdrawn prior to sample collection or one volume if well can be purged dry. The volume of water present in each well shall be computed based on the length of water column and well casing diameter. The water volume shall be computed using Figure 2.

6.0 Well-Purging Methods

6.1 Introduction

Purging must be performed for all ground-water monitoring wells prior to sample collection in order to remove stagnant water from within the well casing and ensure that a representative sample is obtained. The following sections explain the proper procedures for purging and collecting water samples from monitoring wells.

Three general types of equipment are used for well purging: bailers, surface pumps, or down-well submersible pumps.

Temperature
consider Turbidity
< 10 NTUs

In all cases pH and/or specific conductance will be monitored during purging. Field parameter values will be entered on the Ground-Water Sample Collection Record along with the corresponding purge volume.

6.2 Bailing

In many cases bailing is the most convenient method for well purging. Bailers are constructed using a variety of materials; generally, PVC stainless steel, and Teflon®. Care must be taken to select a specific type of bailer that suits a study's particular needs. Teflon® bailers are generally most "inert" and are used most frequently. Keep in mind the diameter of each monitoring well so that the correct size bailers are taken to the site. It is preferable to use one bailer per well; however, field decontamination is a relatively simple task if required.

Bailing presents two potential problems with well purging. First, increased suspended solids may be present in samples as a result of the turbulence caused by raising and lowering the bailer through the water column. High solids concentrations may require that total suspended solids (TDS) and the chemical character of solids be evaluated during sample analyses. Second, bailing may not be feasible for wells which require that greater than twenty (20) gallons be removed during purging. Such bailing conditions mandate that long periods be spent during purging and sample collection or that centrifugal pumps be used. All ground-water collected from monitoring wells for subsequent volatile organic compound analyses shall be collected using bailers, regardless of the purge method.

6.3 Surface Pumping

Ground-water withdrawal using pumps located at the ground surface is commonly performed with centrifugal or peristaltic pumps.

All applications of surface pumping will be governed by the depth to the ground-water surface. Peristaltic and centrifugal pumps are limited to conditions where ground water need only be raised through approximately 20 feet of vertical distance. The lift potential of a surface pumping system will depend upon the net positive suction head of the pump and the friction losses associated with the particular suction line, as well as the relative percentage of suspended particulates.

Surface pumping can be used for many applications of well purging and ground-water sample collection. In all cases, pumping cannot be used for the collection of samples to be analyzed for volatile organic compounds (VOCs).

6.3.1 Peristaltic Pump

Peristaltic pumps provide a low rate of flow typically in the range of 0.02-0.2 gallons/min (75-750 ml/min). For this reason, peristaltic pumps are not particularly effective for well purging. Peristaltic pumps are suitable for purging situations where disturbance of the water column must be kept minimal for particularly sensitive analyses. Peristaltic pumps are most often used in conjunction with field filtering of samples and therefore can be used to obtain water samples for direct filtration at the wellhead.

6.3.2 Centrifugal Pump

Centrifugal pumps are designed to provide a high rate of pumping, in the range of 10-40 gallons per minute (gpm), depending on pump capacity. Discharge rates can also be regulated somewhat provided the pump has an adjustable throttle.

for VOAs

When centrifugal pumps are used, samples should be obtained from the suction (influent) line during pumping by an entrapment scheme as shown in Figure 3. Construction of this sampling scheme is relatively simple and will not be explained as part of this SOP. It is suggested that if samples cannot be obtained before going through the pump, that samples be obtained by using a bailer once pumping has ceased. Collecting samples from the pump discharge is not recommended.

metals Direct if tubing has been cleaned

6.3.3 Submersible Pump

Submersible pumps provide an effective means for well purging and in some cases sample collection. Submersible pumps are particularly useful for situations where the depth to water table is greater than twenty (20-30) feet and the depth or diameter of the well requires that a large purge volume be removed during purging.

ERT uses the Johnson-Keck pump model SP-81 which has a 1.75 inch diameter pump unit. The pump diameter restricts use to monitoring wells which have inside diameters equal to or greater than two (2) inches. As with other pump-type purge/sample collection methods, submersible pumps will not be used for the collection of samples for analyses of volatile organic compounds. Submersible pumps should never be used for well development as this will seriously damage the pump.

7.0 Sample Collection Procedures

7.1 Bailing

Obtain a clean/decontaminated bailer and a spool of polypropylene rope or equivalent bailer cord. Using the rope at the end of the spool tie a bowline knot or equivalent through the bailer loop. Test the knot for security and the bailer itself to ensure that all parts are intact prior to inserting the bailer into the well.

never lower to the bottom - purge from the top of the water column

Remove the protective foil wrapping from the bailer, and lower the bailer to the bottom of the monitoring well and cut the cord at a proper length. Boiler rope should never touch the ground surface at any time during the purge routine.

Raise the bailer by grasping a section of cord using each hand alternately in a "rocking" action. This method requires that the samplers' hands be kept approximately 2-3 feet apart and that the bailer rope is alternately looped onto or off each hand as the bailer is raised and lowered.

Bailed ground water is poured from the bailer into a graduated bucket to measure the purged water volume.

NO!

For slowly recharging wells, the bailer is generally lowered to the bottom of the monitoring well and withdrawn slowly through the entire water column. Rapidly recharging wells should be purged by varying the level of bailer insertion to ensure that all stagnant water is removed. The water column should be allowed to recover to 70-90% of its static volume prior to collecting a sample. Water samples should be obtained from midpoint or lower within the water column.

Samples collected by bailing will be poured directly into sample containers from bailers which are full of fresh ground water. During sample collection, bailers will not be allowed to contact the sample containers.

7.2 Peristaltic Pump

Place a new suction and discharge line to the peristaltic pump. Silicon tubing must be used through the pump head. A second type of tubing may be attached to the silicon tubing to create the suction and discharge lines. Such connection is advantageous for the purpose of reducing tubing costs, but can only be done if airtight connections can be made. Tygon tubing will not be used when performing well purging or collecting samples for organic analysis. The suction line must be long enough to extend to the static ground-water surface and reach further should drawdown occur during pumping.

use of A Vaccumizing assembly prevents passage through the pump so tygon is ok

Measure the length of the suction line and lower it down the monitoring well until the end is in the upper 2-5 inches of the water column present in the well. Start the pump and direct the discharge into a graduated bucket. allow enough extra tubing for drawdown —

what happens when you draw the well down?

Measure the pumping rate in gallons per minute by recording the time required to fill a selected volume of a bucket. Flow measurement shall be performed three times to obtain an average rate.

The pumping shall be monitored to assure continuous discharge. If drawdown causes the discharge to stop, the suction line will be lowered very slowly further down into the well until pumping restarts. — Slow the rate to match the recharge if not possible — purge to dryness — recover, sample.

Measurements of pH and specific conductance will be made periodically during well purging. All readings will be entered on the Ground-Water Sample Collection Record.

Samples will be collected after the required purge volume has been withdrawn and the field parameters (pH and Specific Conductance) have stabilized.

When the sample bottles are prepared, each shall be filled directly from the discharge line of the peristaltic pump. Care will be taken to keep the pump discharge line from contacting the sample bottles. Ground-water samples requiring filtration prior to placement in sample containers, will be placed in intermediate containers for subsequent filtration or filtered directly using the peristatic pump.

At each monitoring point when use of the peristaltic pump is complete, all tubing including the suction line, pump head and discharge line must be disposed of. In some cases where sampling will be performed frequently at the same point, the peristaltic pump tubing may be retained between each use in a clean zip-lock plastic bag.

7.3 Centrifugal Pump

7.3.1 Direct Connection Method (Note: This method requires that the well casing be threaded at the top.)

Establish direct connection to the top of the monitoring well if possible using pipe connections, extensions, and elbows, with Teflon® tape wrapping on all threaded connections. If the centrifugal pump will subsequently be used for sample collection, a sample isolation chamber will be placed in the suction line configuration as shown in Figure 3.

Prime the pump by adding tap water to the pump housing until the housing begins to overflow.

Start the pump and direct the discharge into a graduated bucket or a bucket of known capacity (>2.5 gallons).

Start the pump and measure the pumping rate in gallons per minute by recording the time required to fill the graduated bucket. Flow measurement should be checked periodically to determine if pumping rates are continuous, fluctuating, or diminishing. If discharge stops, the pump will be throttled back to determine if pumping will restart at a lower rate. If pumping does not restart, the pump should be shut off to allow the well to recharge.

a Well Purged Dry is ready to sample upon recovery

Measurements of pH and specific conductance will be made periodically during well purging. All readings will be entered on the Ground-Water Sample Collection Record. Samples will be collected after the required purge volume has been withdrawn and the field parameters (pH and Specific Conductance) have stabilized. Samples should be collected from an in-line discharge valve or with a bailer. The pump should be properly decontaminated between wells.

7.3.2 Down-Well Suction-Line Method

Lower a new suction line into the well. The suction line will have a total length great enough to extend to the water table and account for a minimum of five (5) feet of drawdown. Note should be made that drawdown may exceed the depth where pumping will terminate as a result of a limitation derived from suction-line conditions and the lift potential of the pump. All connections should be made using Teflon® ferrules and Teflon® thread wrapping tape. Run the pump as per Section 7.3.1.

At each monitoring well when use of a centrifugal pump is complete, all suction line tubing should be disposed of properly.

7.4 Submersible Pump

Prior to using a submersible pump, a check will be made of well diameter and alignment. A 1.75 inch diameter decontaminated cylindrical tube should be lowered to the bottom of each monitoring well to determine if the alignment or plumbness of a well is adequate to accommodate the submersible pump. All observations will be entered in the Ground-Water Sample Collection Record.

Slowly lower the submersible pump into the monitoring well taking notice of any roughness or restrictions within the riser.

Count the graduations on the pump discharge line and stop lowering when the stainless steel portion is below the uppermost section of the static water column within monitoring well. Secure the discharge line and power cord to the well casing.

Connect the power cord to the power source (i.e., rechargeable battery pack or auto battery monitor) and turn the pump on (forward mode). When running, the pump can usually be heard by listening near the well head.

Voltage and amperage meter readings on the pump discharge must be checked continuously. The voltage reading will decline slowly during the course of a field day representing the use of power from the battery. Amperage readings will vary depending upon the depth to water table. Amperage readings greater than 10 amps usually indicate a high solids content in the ground water which may cause pump clogging and serious damage. If a steady increase in amperage is observed, the pump should be shut off, allowed to stop, switched to the reverse mode, stopped again and then placed in forward mode. If high amperage readings persist, the pump should be withdrawn and checked using the large upright cylinder and tap water. Ground-water conditions such as high solids may require that an alternate purge/sample method be used.

Drawdown must also be monitored continuously by remaining near the well at all times and listening to the pump. When drawdown occurs, a metallic rotary sound will be heard as the pump intake becomes exposed and ceases to discharge water, but continues to run. The pump should be lowered immediately to continue pumping water within the uppermost section of the static water column. NOTE: The submersible pump cannot be allowed to run while not pumping for more than five seconds or the pump motor will burn out.

If drawdown continues to the extent that the well is pumped dry, the pump should be shut off and the well allowed to recharge. This on/off cycle may need to be repeated several times in order to purge the well properly.

Measurements of the pumping rate, pH, and specific conductance should be made periodically during well purging. All readings and respective purge volumes should be entered on the Ground-Water Sample Collection Record.

While pumping is on-going and when sample bottles are prepared, bottles will be filled directly from the discharge line of the pump taking care not to touch sample bottles to the discharge line.

At each monitoring well when use of the submersible pump is complete, the pump, discharge line and power cord shall be decontaminated according to the procedures contained in the SOP for Decontamination.

8.0 Sample Preparation

8.1 Introduction

Prior to sample transport or shipment, ground-water samples may require filtration and/or preservation dependent on the specific type of analysis required.

Specific preservation techniques are described in the EPA document, Handbook for Sampling and Sample Preservation of Water and Wastewater (EPA-600/4-82-029). The EPA manual and laboratory manager should be consulted during the planning stage of the project. Project-specific sampling plans shall be assembled using the approved procedures obtained from the EPA manual.

8.2 Filtration

Not in Region IV Samples are not filtered!

Ground-water samples collected for dissolved metals analyses will be filtered prior to being placed in sample containers. Ground-water filtration will be performed using a peristaltic pump and a 0.45 micron, water filter. Typically the water filters are 142 mm in diameter and are usually placed in 142 mm polycarbonate housings.

The filtration of ground-water samples shall be performed either directly from the monitoring well or from intermediate sample containers such as decontaminated buckets. In either case, well purging shall be performed first. Fresh ground water shall then be filtered and discharged from the filtration apparatus directly into sample containers. For most dissolved metal analyses, pH adjustment of the sample is also required and shall be performed after filling the sample bottles. This is generally accomplished using laboratory supplied compounds such as sulfuric or nitric acid and sodium hydroxide.

for metals for Cyanide

9.0 Documentation

A number of different documents must be completed and maintained as a part of ground-water sampling effort. The documents provide a summary of the sample-collection procedures and conditions, shipment method, the analyses requested and the custody history. The list of documents is:

- Ground-water sample collection record
- Sample labels
- Chain of custody forms and tape
- Shipping receipts

Sample labels shall be completed at the time each sample is collected and will include the information listed below. A sample label is shown in Figure 4.

- Client or project name
- Sample number
- Designation (i.e., identification of sample point no.)
- Analysis
- Preservative (e.g., filtration, acidified pH<2 HNO_3)
- Sample-collection date
- Sampler's name

Figure 5 displays the chain of custody record used by ERT. The chain of custody form is the record sample collection and transfer of custody. Information such as the sample collection date and time of collection, sample identification and origination, client or project name shall be entered on each chain of custody record. In accordance with 40 CFR 261.4(d) the following information must accompany all ground water samples which are known to be non-hazardous and to which U.S. Department of Transportation and U.S. Post Office regulations do not apply. Such information is:

- sample collector's name, mailing address and telephone number,
- analytical laboratory's name, mailing address and telephone number,
- quantity of each sample,
- date of shipment, and
- description of sample.

The chain of custody forms provide a location for entry of the above-listed information.

10.0 References

EPA, Handbook for Sampling and Sample Preservation of Water and Wastewater EPA-600/4-82-029, September 1982.

Geotrans, Inc. RCRA Permit Writer's Manual, Ground-Water Protection prepared for U.S. EPA. Contract No. 68-01-6464, October 1983.

Code of Federal Regulations, Chapter 40 (Section 261.4(d).

Figure 1

ENSR

Well No. ______

GROUND WATER SAMPLE COLLECTION RECORD

Job No. __________ Date: __________

Location: ______________________ Time: S ______

Weather Conds.: ______________________ F ______

1. WATER LEVEL DATA: (from ToC) ToC Elevation (from LS) __________
   a. Total Well Length (+ TC) __________ (known, meas.) Tape Corr. (TC) __________
   b. Water Table Elev. (+ TC) __________ Well Dia. __________
   c. Length of Water Column __________ (a-b)

2. WELL PURGING DATA:
   a. Purge Method ______________________
   b. Required Purge Volume (@ ___ well volumes) ______________________
   c. Field Testing: Equipment Used ______________________

Volume Removed	T°	PH	Spec. Cond.	Color

3. Sample Collection: Method ______________________

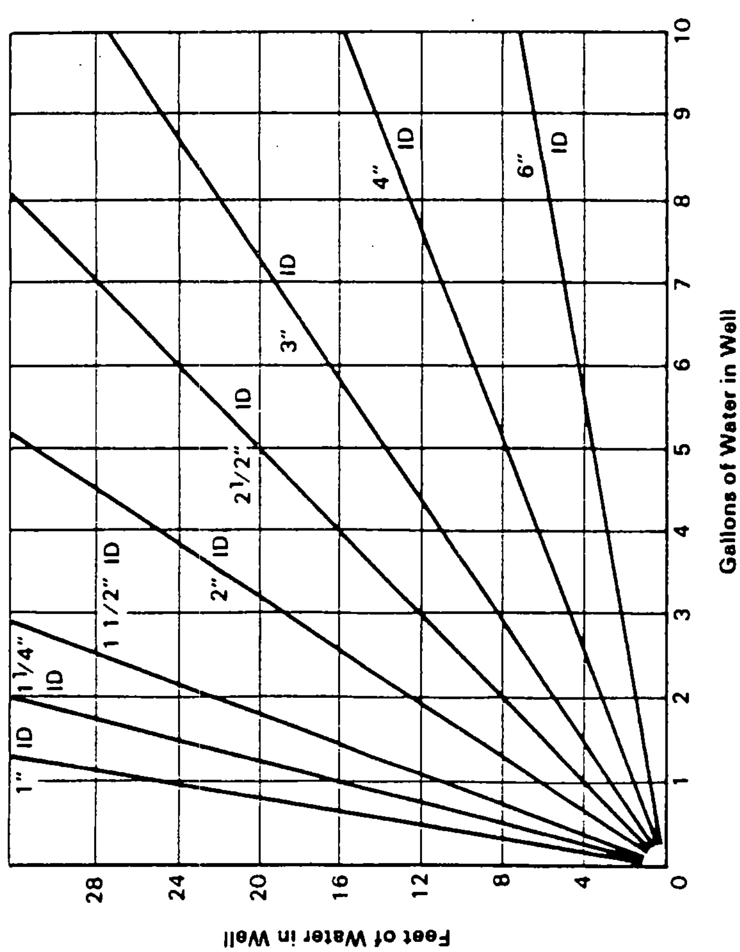
Container Type	Preservation	Analysis Req.

Comments: ______________________

1995 12-84

Volume/Linear Ft. of Pipe		
ID(in)	Gal	Liter
1/4	0.003	0.010
3/8	0.006	0.022
1/2	0.010	0.039
3/4	0.023	0.087
1	0.041	0.154
2	0.163	0.618
3	0.367	1.39
4	0.653	2.47
6	1.47	5.56

(b) Volume Factors



(a) Graphical Explanation

Figure 2 Purge Volume Computation

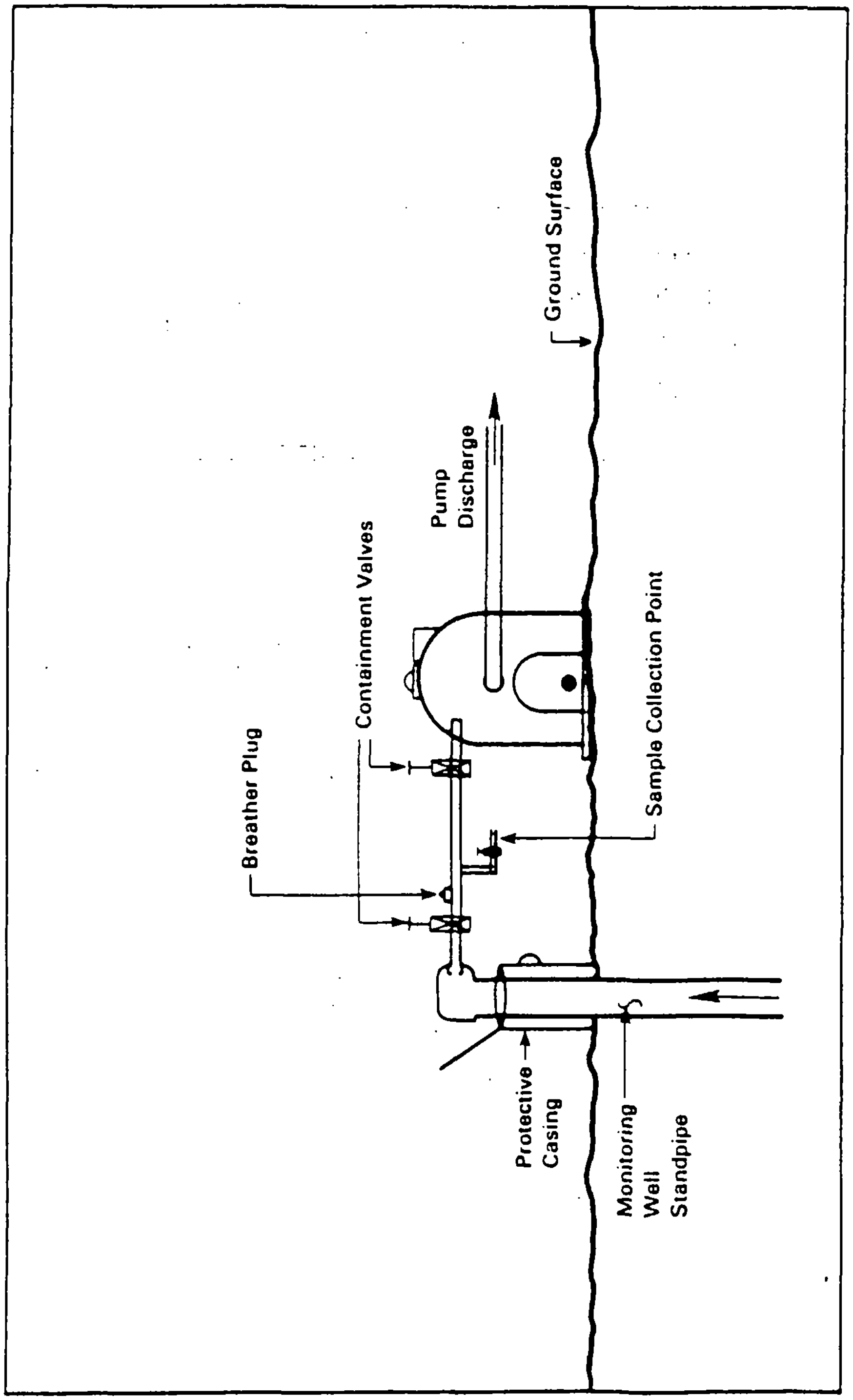


Figure 3 Down Well Suction Line Configuration

CLIENT ______________________

SAMPLE NO. ______________________

DESIGNATION ______________________

ANALYSIS ______________________

PRESERVATIVE ______________________

DATE ____________ BY ____________

Figure 4 Sample Container Label

CHAIN OF CUSTODY RECORD

Client/Project Name	Project Location
Project No.	Field Logbook No.
Sampler: (*Signature*)	Chain of Custody Tape No.

Sample No./ Identification	Date	Time	Lab Sample Number	Type of Sample	ANALYSES							REMARKS

Relinquished by: (*Signature*)	Date	Time	Received by: (*Signature*)	Date	Time
Relinquished by: (*Signature*)	Date	Time	Received by: (*Signature*)	Date	Time
Relinquished by: (*Signature*)	Date	Time	Received for Laboratory: (*Signature*)	Date	Time
Sample Disposal Method:	Disposed of by: (*Signature*)			Date	Time
SAMPLE COLLECTOR	ANALYTICAL LABORATORY				No.

1974-3-84

Figure 5 Sample Chain-of-Custody Record

Title: Monitoring Well Construction and Installation

1.0 Purpose and Applicability

This SOP establishes the method for installing ground water monitoring wells. These wells will be installed to monitor the depth to ground water, to measure aquifer properties, and to obtain samples of ground water for chemical analysis.

2.0 Definitions

Annulus: The space between the borehole wall and the outside of the well screen or riser pipe.

Filter Pack: A well-graded, clean sand or gravel placed around the well screen to prevent the entry of very fine soil particles.

Grout Plug: A cement/bentonite mixture use to seal a borehole that has been drilled to a depth greater than the final depth at which the monitoring well is to be installed.

Guard Pipe: A pipe, usually made of steel, placed around that portion of the well riser pipe that extends above the ground surface. As well as providing security to a well, it may provide a fixed elevation for surveying.

Riser Pipe: The section of unperforated well construction material used to connect the well screen with the ground surface. Frequently it is made of the same material and has the same diameter as the well screen.

Road Box: A man-hole set into the ground around a well installation. Usually constructed in areas where the monitoring well cannot extend above the ground surface for traffic or security reasons.

Tremie Pipe: A small diameter pipe that will fit in the annulus and is used to inject filter sands, seal materials, or cement/bentonite grout under pressure.

Well Screen: That portion of the well casing material that is perforated in some manner so as to provide a hydraulic connection to the aquifer. Typically a well screen has slots but holes, slits, louvers, and other perforations can, in some situations, be used.

3.0 Health and Safety Considerations

Monitoring well installation may involve chemical hazards associated with materials in the soil or aquifer being explored; and always involves physical hazards associated with the drill rig and well construction methods. When wells are to be installed in locations where the aquifer and/or overlying materials may contain chemical hazards, a Health and Safety Plan must be prepared and approved by the Health and Safety Officer before field work commences.

In addition, the following protective measures are required:

- all persons within 50 feet of the drill rig must wear hard hats and safety shoes. Hearing protection must be provided during periods of excessive noise; and

- personnel who are not directly involved in overseeing, inspecting or performing the drilling and well installation will remain at least 100 feet away from the drill rig.

4.0 Quality Assurance Planning Considerations

The following aspects of monitoring well design and installation procedures will depend on project-specific objectives and circumstances and should be addressed in the Quality Assurance Project Plan (QAPP).

- Construction materials for well screen, riser, filter pack and seals;

- Borehole drilling method;

- Depth and length of screen;

- Location and composition of seals; and

- Well head completion and protection.

Some states and EPA Regions have promulgated comprehensive guidelines for monitoring well configuration, and for subsurface investigation procedures. These will be followed as applicable, and the adaption of this SOP to accommodate those requirements will be explained in the QAPP.

5.0 Responsibilities

It is the responsibility of the Project Manager to ensure that each project involving monitoring well installation is properly planned and executed, and that the safety of personnel from chemical and physical hazards associated with drilling and well installation is protected.

Some states have specific requirements regarding the construction of monitoring wells. It is the responsibility of the Project Manager to understand these regulations and any permitting requirements that may be necessary, and to ensure that the well installation program complies with all state and local requirements.

It is the responsibility of the Project Geologist or Engineer to directly oversee the construction and installation of the monitoring well by the subcontract driller to ensure that the well-installation specifications defined in the project work plan are adhered to and that all pertinent data are recorded on the approved forms.

6.0 Training/Qualifications

Each person designing monitoring wells for ENSR projects and overseeing their installation should be a degreed geologist or hydrogeologist with at least two years experience in ground water monitoring. Specific training and/or orientation will be provided for each project to ensure that personnel understand the objectives and special circumstances and requirements of that project.

7.0 Supporting Materials

The monitoring well shall consist of a commercially available well screen constructed of PVC, stainless steel, teflon, or fiberglass pipe of minimum 2-inch nominal diameter. The length of the screen and the size of the screen slots shall be determined by the inspecting geologist or specified in the project work plan depending upon the grain-size distribution of the aquifer materials. PVC, stainless steel, steel, teflon, or fiberglass riser pipe of minimum 2-inch nominal diameter shall be used to complete the monitoring well to ground surface. The riser pipe shall be connected by flush-threaded, coupled or welded watertight joints. No solvent or anti-sieze compound shall be used on the joints.

The section of riser pipe that sticks up above ground shall be protected by a steel guard pipe set at least 2 feet into a concrete surface seal. The top of the guard pipe shall have a vented lockable cap. Alternatively, a road box may be installed, if it satisfies the security requirements of the project. Road-box installations must use a watertight seal inside of the riser pipe to prevent surface water from entering the well.

Other materials used for well construction include silica sand, bentonite, cement, and a calibrated tape for length measurements and water-level measurements. Construction materials are generally provided by the drilling subcontractor.

8.0 Method

8.1 Borehole Requirements

The diameter of the borehole must be a minimum of 2 inches greater than the outside diameter of the well screen or riser pipe used to construct the well. This is necessary so that sufficient annular space is available to install filter packs, bentonite seals, and grout seals.

Rotary drilling methods requiring bentonite-based drilling fluids should be used with caution to drill boreholes that will be used for monitoring well installation. The bentonite mud builds up on the borehole walls as a filter cake and permeates the adjacent formation, significantly reducing the permeability of the material adjacent to the well screen.

If water or other drilling fluids have been introduced into the boring during drilling or well installation, samples of these fluids should be obtained and analyzed for chemical constituents that may be of interest at the site.

8.2 Procedure for Construction

8.2.1 After drilling and soil sampling have been completed, the borehole shall be checked for total open depth with a weighted, calibrated tape measure.

8.2.2 If the borehole has been advanced to a depth greater than that of the bottom of the well to be installed, bottom grouting, or bentonite pellet sealing, of the borehole will be required. A heavy plumb bob on a calibrated tape shall be used to determine the total depth of the boring. This depth measurement shall be used with the required bottom elevation of the well screen to calculate the thickness of the grout plug. If bottom grouting is necessary, then provisions should be made to support the screen and riser pipe to prevent them from sinking into the grout. The depth to the top of the grout should be checked often with a weighted tape measure.

8.2.3 The assembled screen and riser or its constituent parts shall be decontaminated with a detergent and water wash and triple deionized water rinse. Steam-cleaning also can be done to decontaminate the well materials. Decontaminated well components should be wrapped in plastic until installed in the boring. All personnel handling the decontaminated well components should exercise great care not to contaminate these components as they are installed in the borehole.

8.2.4 The well screen and riser pipe generally are assembled as they are lowered into the borehole. As the assembled well is lowered, care shall be taken to ensure that it is centered in the hole. In boreholes which are determined to be not plumb, centralizers should be used on the tail pipe below the screen and/or the midpoint and top of the screen. This will assure that the screened portion of the well is centrally located in the borehole with a uniform thickness of sand or filter pack between the screen and the borehole wall. In holes greater than 25 feet in depth, centralizers should be used.

8.2.5 The annular space surrounding the screened section of the monitoring well and at least ~~1~~ foot above the top of the screen shall be filled with an appropriately graded, clean sand or gravel. In no case shall the sand pack be longer than 1.5 times the length of the screen. ~~A minimum 1-foot thick layer of very fine sand (i.e., sand-blasting sand)~~ should be placed immediately above the well screen sand pack. This layer is designed to prevent the infiltration of sealing components (bentonite or grout) into the sand pack. As each layer is placed, a weighted tape should be lowered in the annular space to verify the depth to the top of the layer.

2 ft Above

no → Stated correctly in Sect 4.3 of this DOC

Depending on the depth of the well, the diameters of the borehole and well materials, and the depth to the static water level, satisfactory placement of the sand pack may require the use of a tremie pipe.

8.2.6 Bentonite seals, either pellets or slurry, a minimum of 2 feet thick shall be installed immediately above the artificial gravel pack in all monitoring wells. The purpose of the seal is to provide a barrier to vertical flow of water in the annular space between the borehole and

? Where did this come from?

the well. Bentonite is used because it swells significantly upon contact with water. Pellets generally can be installed in shallow boreholes by pouring them very slowly from the surface. If they are poured too quickly, they may bridge at some shallow, undesired depth. Powdered bentonite shall be installed by mixing a very thick slurry and using a tremie pipe to inject the seal material at the desired depth in the borehole. Bentonite slurry should be pumped into the annular space using a side-discharge tremie pipe located about 2 feet above the fine-sand pack. Side discharge will ensure the integrity of the sand pack.

In situations where the monitoring well screen straddles the water table, the seal will be in the unsaturated zone and pure bentonites (pellets or powder) will not work effectively as seals due to dessication. Seals in this situation should be a cement/bentonite mixture containing 2 to 10 percent bentonite by weight. This type of mixture shall be tremied to the desired depth in the borehole.

8.2.7 The remaining length of borehole shall be backfilled with grout to within 2 feet of the ground surface. This grouting will consist of a cement/bentonite mixture. A tremie pipe shall be used to install the grout. Drill cuttings, even those known not to be contaminated, shall not be used as backfill material.

8.2.8 The steel guard-pipe shall be placed around the riser, and the borehole around the guard pipe shall be dug out to approximately a 1-foot radius to a depth of 2 feet, and filled with concrete. The concrete pad shall be sloped so that drainage occurs away from the well. All completed wells will have identification numbers clearly painted on the cap and guard pipe with bright colored paint.

Generally, the protective guard pipe will be lockable. A point on the top of the riser pipe will be marked (paint spot or cut notch) to indicate the surveyed elevation position, known as the "measuring point" (MP).

ok

A vent hole must be installed in the protective casing in an area that is protected from precipitation. Road box installations should not be vented.

but not ok on drawing

8.2.9 Measure the depth to the stabilized water level and record on the ground water monitoring well detail report (shown as Figure 1).

8.2.10 At some point after installation of a well and prior to use of the well for water level measurements or water quality samples, development of the well shall be undertaken in accordance with ENSR SOP 7221, Monitoring Well Development.

9.0 Quality Control Checks and Acceptance Criteria

- The borehole will be checked for total open depth, and extended by further drilling or shortened with a grout plug, if necessary, before any well construction materials are placed.

- Water level will be checked repeatedly during well installation to ensure that the positions of well screen, sand pack and seal, relative to water level, conform to project requirements.

- The depth to the top of each layer of packing (i.e., sand, bentonite, grout, etc.) will be verified and adjusted if necessary to conform to the requirements of this SOP and the QAPP before the next layer is placed.

10.0 Documentation

During installation of each monitoring well, a series of measurements shall be taken and recorded. These measurements shall include:

- length of tail pipe (if used)
- length of screen
- length of riser pipe
- total length of well
- depth to stabilized water level

Other data include the screen and riser pipe materials, diameters of the respective components, screen slot size, type and thickness of the sand pack, thicknesses and different types of grouting materials, and elevation of the top of the guard pipe, established measuring point, and ground surface after surveying is complete. If water or other drilling fluids have been introduced into the boring during drilling or well installation, samples of fluids should be obtained and analyzed for chemical constituents that may be of interest at the site.

All data shall be recorded on site onto the ground water monitoring well detail report (shown as Figure 1) and all wells shall be referenced onto the appropriate site map. A field book and/or boring log can be used as additional means of recording data. In no case shall the field book or boring log take the place of the ground water monitoring well detail report. All documentation shall remain in the project files indefinitely.

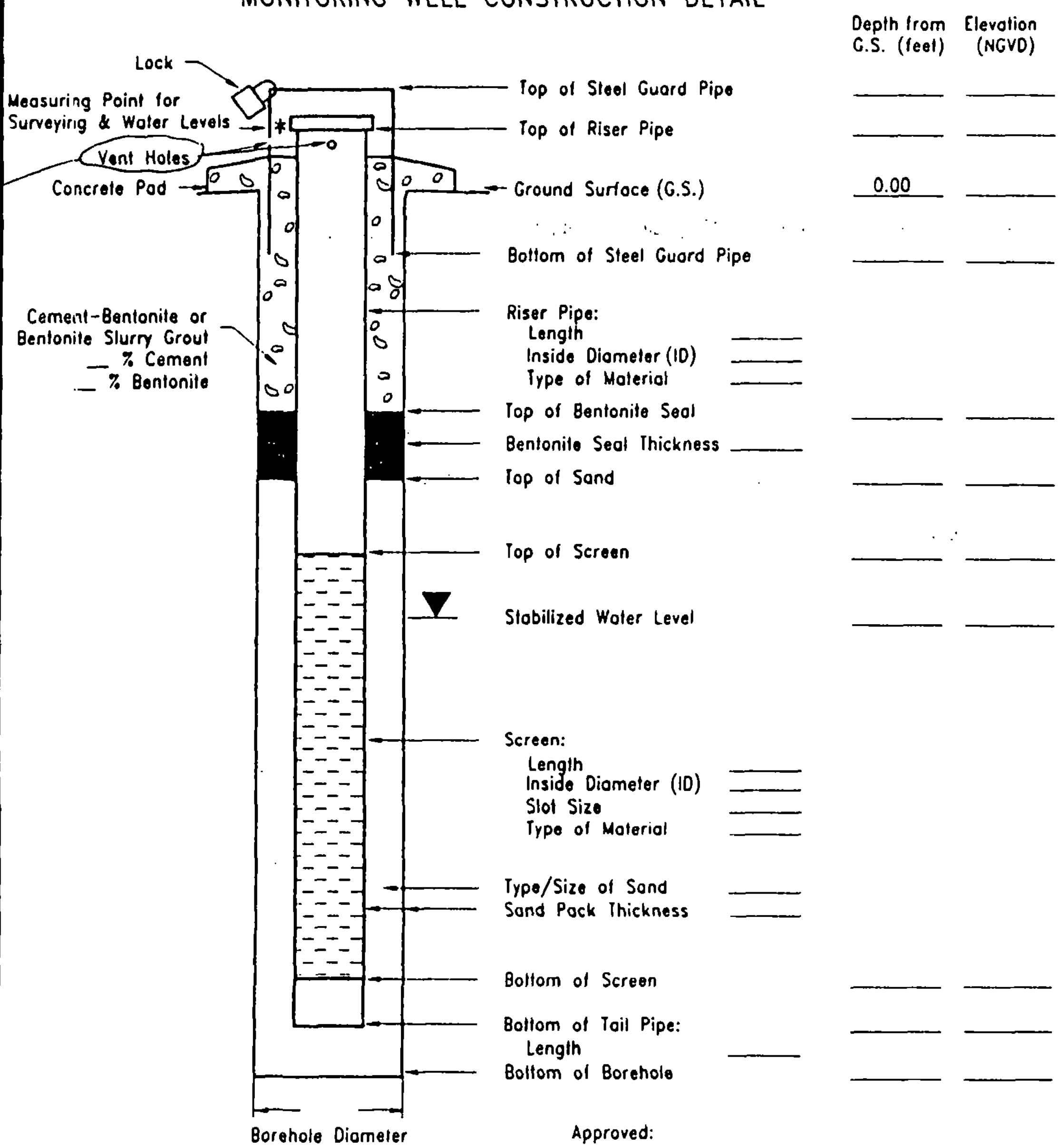
Figure 1

Project No: ______ Client: ______ Site: ______ **WELL No:**

Well Location: ______ Date Installed: __/__/__

Contractor: ______ Method: ______ Inspector: ______

MONITORING WELL CONSTRUCTION DETAIL



Approved:

* Describe Measuring Point: ______

______ Signature ______ Date

ENSR.

well installation, samples of fluids should be obtained and analyzed for chemical constituents that may be of interest at the site.

All data shall be recorded on site onto the ground water monitoring well detail report (shown as Figure 1) and all wells shall be referenced onto the appropriate site map. A field book and/or boring log can be used as additional means of recording data. In no case shall the field book or boring log take the place of the ground water monitoring well detail report. All documentation shall remain in the project files indefinitely.

1.0 Purpose and Applicability

This SOP describes the methods used for developing monitoring wells after original installation and prior to use of the well for obtaining water level measurements or water quality samples. Development should not be confused with purging, the purpose of which is to evacuate the monitoring well system of stagnant water which may not be representative of the aquifer. For purging procedures refer to ENSR SOP No. 7130, Ground-Water Sample Collection from Monitoring Wells.

Monitoring well development and/or rehabilitation are necessary to ensure that complete hydraulic connection is made and maintained between the well and the aquifer material surrounding the well screen and packing materials. Development is necessary after original installation of a monitoring well to (1) reduce the compaction and inter-mixing of grain sizes produced during drilling; (2) to increase the porosity and permeability of the artificial filter pack by removing the finer grain-size fraction introduced near the screen by drilling and well installation; and (3) to remove any foreign drilling fluids that coat the borehole or that may have invaded the adjacent natural formation.

This procedure applies to monitoring wells in which siltation has been determined to have occurred. After a well has been installed for some period of time (ranging from months to years), siltation of the well may occur and rehabilitation will be necessary to re-establish complete hydraulic connection with the aquifer.

2.0 Definitions

Note: Equipment components are defined in Section 7.0 of this SOP.

Bridging: A condition within the filter pack outside the well screen whereby the smaller particles are wedged together in a manner that causes blockage of pore spaces.

Hydraulic Conductivity: A characteristic property of aquifer materials which describes the permeability of the material to a particular fluid (usually water).

Hydraulic Connection: A properly installed and developed monitoring well should have a complete hydraulic connection with the aquifer. The well screen and filter material should not provide any restriction to the flow of water from the aquifer to the well.

Permeability Test: Used to determine the hydraulic conductivity of the aquifer formation near a well screen. Generally conducted by displacing the water level in a well and monitoring the rate of recovery of the water level as it returns to equilibrium. Various methods of analysis are available to calculate the hydraulic conductivity from these data.

Screened Interval: That portion of a monitoring well that is open to the aquifer.

Static Water Level: The water level in a well that represents an equilibrium condition when the aquifer is not being stressed (no nearby withdrawal or injection of water). Since the ground water conditions are generally dynamic, static is a condition that holds true only for short periods of time (anywhere from minutes to years depending on cultural and climatic influences).

Well Surging: That process of moving water in and out of a well screen to remove fine sand, silt and clay size particles from the adjacent formation.

Well Purging: The process of removing water from a well to allow in situ formation water to enter the well. Generally thought of in terms of removing standing water from a well prior to the collection of water samples for quality determination, the process also is conducted to remove suspended particles from the well after well surging.

Well Screen: That portion of the well casing material that is perforated in some manner so as to provide a hydraulic connection to the aquifer. Typically a well screen has slots but holes, slits, louvers, and other perforations can, in some situations, be used.

3.0 Health and Safety Considerations

Monitoring well development may involve chemical hazards associated with materials in the soil or aquifer being explored; and always involves physical hazards associated with the heavy equipment that may be used for various development techniques. When wells are to be installed and developed in locations where the aquifer and/or overlying materials may contain chemical hazards, a Health and Safety Plan must be prepared and approved by the Health and Safety Officer before field work commences.

In addition, the following protective measures are always required:

- all persons within 50 feet of a drill rig must wear hard hats and safety shoes. Hearing protection should be provided during periods of excessive noise; and
- personnel who are not directly involved in overseeing, inspecting or performing the drilling and well installation will remain at least 100 feet away from the drill rig.

4.0 Quality Assurance Planning Considerations

The appropriate development method will be selected for each project on the basis of the circumstances, objectives and requirements of that project. Further, some states and EPA regions have promulgated comprehensive guidelines for ground water monitoring and subsurface investigation procedures. The provisions of this SOP will be adapted to these project-specific requirements in the Quality Assurance Project Plan (QAPP). Each QAPP will describe the specific method(s) to be used and the rationale, including trade-offs associated with the nature of the aquifer formation, chemical analytical objectives, and client or agency requirements.

5.0 Responsibilities

Development of new monitoring wells is the responsibility of the geologist or hydrogeologist involved in the original installation of the well. The geologist may, in fact, contract with the well driller to develop new wells under the geologist's guidance and oversight. Records of well development methods and results are to be kept by the geologist.

Any person using existing monitoring wells for any purpose is responsible for verifying the original well construction details and determining if a well requires rehabilitation.

6.0 Training/Qualifications

Each ENSR employee who develops a monitoring well for an ENSR project will have been trained by an experienced ENSR geologist in the specific procedure used.

7.0 Supporting Materials

The following list identifies the types of equipment which may be used to develop monitoring wells. Exact equipment needs will be well-specific and will depend upon the diameter of the well, the depth to the static water level and other factors.

7.1 Surge Block

A surge block consists of a rubber (or leather) and metal plunger attached to rod or pipe of sufficient length to reach the bottom of the well. Well drillers usually can provide surge blocks for large diameter wells (greater than 6 inches). Surge blocks for smaller diameter wells can be constructed easily of materials readily accessible in any hardware store. A recommended design is shown in Figure 1. To reduce cross-contamination of monitoring wells, a new plunger generally is used in each well to be developed and the rod is decontaminated in accordance with procedures in ENSR SOP 7600, Decontamination of Equipment.

7.2 Pump

A pump is necessary to remove large quantities of silt-laden ground water from a well after using the surge block. In some situations, the pump alone is used to both surge the well and remove the fines. Since the purpose of well development is to remove suspended solids from a well, the pump must be capable of moving some solids without damage. The preferred pump is a centrifugal because of its ability to pump solids, but a centrifugal pump will work only where the depth to static ground water is less than approximately 25 feet. In deep ground water situations, a positive-displacement pump such as a submersible or bladder pump will be necessary.

7.3 Bailer

A bailer is to be used to purge silt-laden water from wells after using the surge block. In some situations, the bailer can be used to surge a well but the use of a bailer for surging is not recommended. The bailer is to be used for purging in situations where the depth to static water is greater than 25 feet and the silt loading is greater than that which can be handled by positive-displacement pumps.

7.4 Compressed Gas

Compressed gas, generally nitrogen, can be used to both surge and purge a monitoring well. A nitrogen tank is used to inject gas at the bottom of the water column, driving sediment-laden water to the surface. Compressed gas can also be used for "jetting" - a process by which the gas is directed at the slots in the well screen to cause turbulence (thereby disturbing fine materials in the adjacent filter pack). Compressed gas is not limited to any depth range.

The hose or pipe which will be installed in the well for jetting should be equipped with a horizontal (side) discharge nozzle and one or more small holes in the bottom of the hose to enhance the lifting of sediment during jetting.

Since the compressed gas will be used to "lift" water from the monitoring well, provisions must be made for controlling the discharge from contaminated wells. This is generally accomplished by attaching a "tee" discharge to the top of the casing and providing drums to contain the discharged water. Gas-lifting must never be done in contaminated wells without providing discharge control apparatus.

7.5 Decontamination Equipment

Standard equipment for decontaminating field apparatus in accordance with ENSR SOP 7600 will be used to decontaminate all equipment used to develop monitoring wells.

7.6 Purge Water and Sediment Disposal

The QAPP must specify the means for disposing of purged sediment-laden water. In most cases, disposal of this material will follow the methods used in the original installation of the borehole. If soil and/or ground water contamination conditions in a well have changed, it may be necessary to specify new disposal methods for wells that are being re-developed.

7.7 Monitoring Well Construction Details

A copy of the original Monitoring Well Construction Detail form for the well to be developed must be obtained from the project manager. This form provides critical information regarding the construction of the monitoring well and must be in the possession of the well development crew so that pertinent well construction details, such as total depth, are known.

7.8 Supporting SOPs

- 7130 - Ground-Water Sample Collection from Monitoring Wells
- 7220 - Monitoring Well Construction and Installation
- 7600 - Decontamination of Equipment
- 7720 - Rising-Head/Falling-Head Permeability Testing

8.0 Procedure for Well Development

8.1 General Procedure

8.1.1 Conduct a permeability test as described in ENSR SOP 7720 to determine the hydraulic conductivity of the screened interval. The results of this test, along with other tests conducted during the development process, will be used to evaluate the success of the development.

8.1.2 Water is caused to move in and out through the monitoring well screen to move silt and clay particles out of the filter pack around the well screen and into suspension within the well. Water movement is effected using a surge block, bailer, or a compressed gas. In some situations, pumping water may effect satisfactory development, but pumping alone is not generally recommended.

8.1.3 The sediment-laden water is removed from the monitoring well using a pump, bailer, or air compressor.

8.1.4 Surging of the well is continued until the water removed is essentially free of suspended silt and clay particles. During the surging/purging cycles, a permeability test should be performed as described in ENSR SOP 7720 to monitor and evaluate the development process.

8.1.5 Generally, a permeability test as described in ENSR SOP 7720 is used to confirm that a reliable hydraulic connection has been established (or re-established) between the well and the surrounding aquifer material.

8.2 Selection of a Specific Procedure

The construction details of the well can be used to initially define the method of purging a well with due consideration being given to the level of contamination.

The criteria for selecting a well development method include well diameter, total well depth, static water depth, screen length, the likelihood and level of contamination, and the type of geologic formation adjacent to the screened interval.

The limitations, if any, of a specific procedure are discussed within each of the following procedures.

Methods that involve placing water into the well may be objectionable to some state and federal agencies. In such cases the surge block procedure may be preferable over the pumping procedure.

8.3 Specific Procedure: Surge Block

8.3.1 A surge block effectively develops most monitoring wells. If the geologic layering in the screened interval includes permeable and impermeable layers (e.g., gravels and clays), it is possible that surging could remove fines from the impermeable layers and force them into the permeable layers. This problem can be minimized by using fewer surging cycles, using a surge block which is looser fitting and/or increasing the purging volume or time of development.

8.3.2 Construct a surge block using the design in Figure 1 as a guide. Specific materials will depend upon the diameter of well to be developed. The diameter of the flexible rings must be sufficient to cause a tight seal within the well casing, and the rods must be of sufficient length to reach to the bottom of the monitoring well.

8.3.3 Insert the surge block into the well and lower it slowly to the level of static water. Start the surge action slowly and gently above the well screen using the water column to transmit the surge action to the screened interval. A slow initial surging, using plunger strokes of 3 to 5 feet, will allow material which is blocking the screen to separate and become suspended.

8.3.4 After a number (5 to 10) of plunger strokes, remove the surge block and purge the well using a pump or bailer. The returned water should be heavily laden with suspended silt and clay particles. As development continues, slowly increase the depth of surging to the bottom of the well screen. For monitoring wells with long screens (greater than 10 feet) surging should be undertaken along the entire screen length in short intervals (2 to 3 feet) at a time.

8.3.5 Continue this cycle of surging and purging until the water yielded by the well is free of visible suspended material.

8.4 Specific Procedure: Pump

8.4.1 Well development using only a pump is most effective in those monitoring wells that will yield water continuously. Effective development cannot be accomplished if the pump has to be shut off to allow the well to recharge.

8.4.2 Set the intake of the pump in the center of the screened interval of the monitoring well.

8.4.3 Pump a minimum of three well volumes of water from the well while using the intake hose of the pump as a plunger. The motion of the intake hose will act to a limited extent as a surge block.

8.4.4 Occasionally, where appropriate, use the pump to fill the monitoring well to the top of the casing and allow the water level to decline to the static level, thereby forcing water back into the formation. This action will cause water to exit the well screen and reduce the bridging of materials caused by water flowing in one direction through the well screen while pumping.

The water used to fill the monitoring well should be the same water removed from the well during the previous pumping cycle. The sediment previously pumped from the well must be removed from the water prior to re-introduction to the well. A steel drum can be used as a sediment-settling vessel.

8.4.5 Continue pumping water into and out from the well until sediment-free water is obtained.

8.5 Specific Procedure: Bailer

8.5.1 Lower the bailer into the screened interval of the monitoring well.

8.5.2 Using long, slow strokes, raise and lower the bailer in the screened interval simulating the action of a surge block.

8.5.3 Periodically bail standing water from the well to remove silt and clay particles drawn into the well.

8.5.4 Continue surging the well using the bailer and bailing water from the well until sediment-free water is obtained.

8.6 Specific Procedure: Compressed Gas (Nitrogen)

8.6.1 Although the equipment used to develop a well using this method is more difficult to handle and use, well development using compressed gas for jetting is considered to be a very effective method. This method also is the most generally applicable because it is not limited by well depth, well diameter or depth to static water, but caution must be exercised in highly permeable formations not to inject gas into the formation.

8.6.2 Lower the gas line from the gas cylinder into the well, setting it near the bottom of the screened interval. Install the discharge control equipment at the well head.

8.6.3 Set the gas flow rate to allow continuous discharge of water from the well. The discharge will contain suspended clay and silt material.

8.6.4 At intervals during gas-lifting, especially when the discharge begins to contain less suspended material, shut off the air flow and allow the water in the well to flow out through the screened interval to disturb any bridging that may have occurred. Re-establish the gas flow when the water level in the well has returned to the pre-development level.

8.6.5 Jetting of the screened interval also can be done during gas-lifting of water and sediment from the well. This is accomplished by using a lateral-discharge nozzle on the gas pipe or hose and slowly moving the nozzle along the length of the screened interval. Jetting should be done beginning at the bottom of the well screen and moving slowly upwards along the screened interval. To enhance gas lifting of sediment, occasionally raise the discharge nozzle into the cased portion of the well and discharge sediment-laden water.

8.6.6 Continue gas-lifting and/or jetting until the water returned in the air stream is free from suspended material.

9.0 Quality Control Checks

A well has been successfully developed when one or more of the following criteria are met:

- the well yields only clear, sediment-free water.
- two or more permeability tests in accordance with ENSR SOP 7720 yield repeatable hydraulic conductivity values.
- the original depth of the well, as described on the Monitoring Well Construction Detail form in ENSR SOP 7220, is clear of sediment and that depth is maintained for some period of time (longer than hours, probably less than one year).

10.0 Documentation

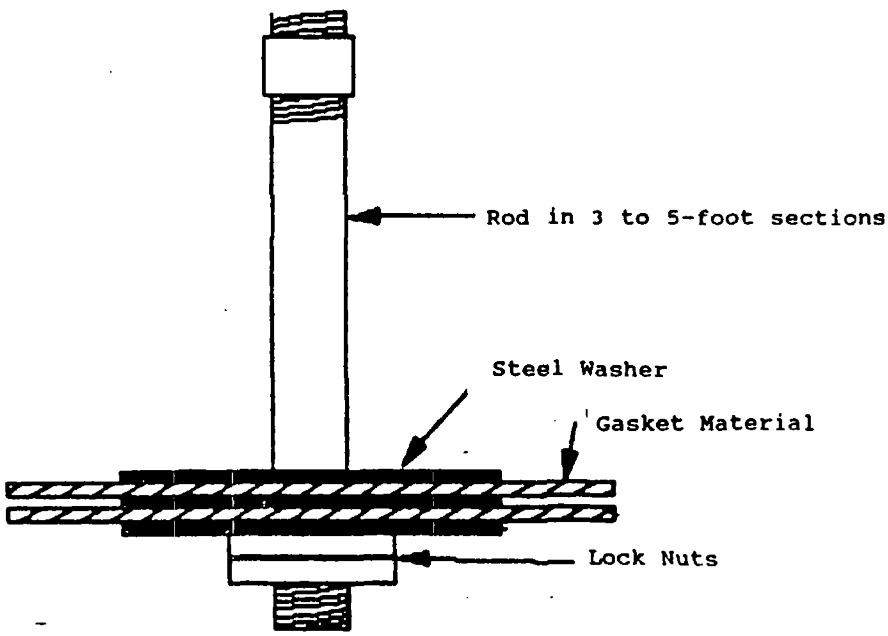
The Monitoring Well Development Record (Figure 2) will be completed by the geologist or hydrogeologist conducting the development. In addition, a field log book should be maintained detailing any problems or unusual conditions which may have occurred during the development process. Any inability to return the well to the original specifications will be noted on the original copy of the Monitoring Well Construction Detail form and on the Monitoring Well Development Record (Figure 2).

All documentation will be retained in the project files following completion of the project.

Figure 1

SURGE BLOCK DESIGN

Steel washers should be 1/2" to 3/4" smaller diameter than the well ID. Gasket can be rubber or leather and should be the same diameter or 1/8" smaller than the well diameter to compensate for swelling of the leather. Rod can be steel, fiberglass, or plastic but must be strong and lightweight.



NOT TO SCALE

ENSR CONSULTING & ENGINEERING

Figure 1

Surge Block Design

IMC | 11/10/88 | SOP 7221

Figure 2

ENSR

MONITORING WELL DEVELOPMENT RECORD

DATE: ______________________ WELL I.D.: ______________________

PROJECT NAME: ______________________ LOCATION: ______________________

PROJECT NUMBER: ______________________ DEVELOPER: ______________________

☐ ORIGINAL DEVELOPMENT ☐ REDEVELOPMENT ORIGINAL DEVELOPMENT DATE: __________

WELL DATA

Well Diameter		Geology at Screened Interval	
Total Well Depth			
Depth to Top of Screen		Likely Contaminants	
Depth to Bottom of Screen			
Depth to Static Water Level		Purge Water and Sediment Disposal Method	

DEVELOPMENT METHOD	PURGING METHOD	PERMEABILITY TEST RESULTS

ACCEPTANCE CRITERIA

Signature ______________________ Date __________

M890322

5.1.3.4 Reverse pump backwashing all removable residual water present in the pump tubing. The pump should be shut off as soon as intermittent flow is observed from the reverse discharge.

5.1.3.5 Rinse the stainless steel submersible down hole pump section with a liberal application of methanol and wipe dry.

5.1.3.6 Place the submersible pump section upright in the cylinder and fill the cylinder with tap water, adding 50-100 ml of methanol for every one liter of water.

5.1.3.7 Activate the pump in the forward mode withdrawing water from the cylinder.

5.1.3.8 Continue pumping until the water in the cylinder is pumped down and air is drawn through the pump. At this time air pockets will be observed in the discharge line. Shut off the pump immediately.

5.1.3.9 Remove the pump from the cylinder and place the pump in the reverse mode allowing that all removable water be discharged on to the ground surface as discussed in Step 2.

5.1.3.10 Using the water remaining in the cylinder, rinse the sealed portion of the power chord and discharge tube by pouring the water carefully over the coiled lines.

5.1.3.11 When reaching the next monitoring well place the pump in the well casing and wipe dry both the power and discharge lines with a clean paper towel as the pump is lowered.

5.1.4 Quality Assurance

To assure that decontamination is complete, field blank samples shall be collected using the cleaned submersible pump. These field blanks will be subsequently analyzed for the parameters of interest with respect to the ground water.

The procedure for collecting the field blanks will comprise using the pump to withdraw the tap water used for decontamination, from the plastic cylinder to sample containers. This field blank sample collection procedure shall only be performed after the materials to be used have been decontaminated.

4.2.2 Wash equipment sampler with the soap or detergent solution.

4.2.3 Rinse with tap water

4.2.4 Rinse with deionized water

4.2.5 Rinse with methanol

4.2.6 Repeat entire procedure or any parts of the procedure if necessary

4.2.7 Allow the equipment or material to air dry before re-using

4.2.8 Dispose of any soiled materials in the designated disposal container

5.0 Specific Decontamination Procedures

5.1 Submersible Pump

5.1.1 Applicability

This procedure will be used to decontaminate submersible pumps between ground-water sample collection points and at the end of each day of use.

5.1.2 Materials

- o plastic-nalgene upright cylinder
- o 5-10 gallon plastic water storage containers
- o methanol and dispenser bottle
- o deionized water and dispenser bottle
- o chemical free paper towels

5.1.3.1 During decontamination the submersible pump will be placed on a clean surface or held away from ground.

5.1.3.2 When removing the submersible pump from each well the power cord and discharge line will be wiped dry using chemical-free disposable towels.

5.1.3.3 Clean the upright plastic-nalgene cylinder with first a methanol and then a deionized water rinse, wiping the free liquids after each.

3.0 Supporting Materials

- cleaning liquids: soap and/or detergent solutions, tap water, deionized water, methanol
- personal safety gear (defined in Project Health and Safety Plan)
- chemical-free paper towels
- disposable gloves
- waste storage containers: drums, boxes, plastic bags
- cleaning containers: plastic buckets, galvanized steel pans
- cleaning brushes

4.0 Methods or Protocol for Decontamination

4.1 General Procedures

4.1.1 The extent of known contamination will determine to what extent the equipment needs to be decontaminated. If the extent of contamination cannot be readily determined, cleaning should be done according to the assumption that the equipment is highly contaminated until enough data are available to allow assessment of the actual level of contamination.

4.1.2 Adequate supplies of all materials must be kept on hand. This includes all rinsing liquids and other materials listed in Section 3.0.

4.1.3 The standard procedures listed in the following section can be considered the procedure for full field decontamination. If different or more elaborate procedures are required for a specific project, they will be spelled out in the project work plan. Such variations in decontamination may include following all, just part, or an expanded scope of the decontamination procedure stated herein.

4.2 Standard Procedures

4.2.1 Remove any solid particles from the equipment or material by brushing and then rinsing with available tap water. This initial step is performed to remove gross contamination.

STANDARD OPERATING PROCEDURE

Title: Decontamination

Date: 1st Qtr 19
Number: 7600
Revision: 1

1.0 General Applicability

This SOP describes the methods to be used for the decontaminization of all field equipment which becomes potentially contaminated during a sample collection task. The equipment may include split spoons, bailers, trowels, shovels, hand augers, or any other type of equipment used during field activities.

Decontamination is performed as a quality assurance measure and a safety precaution. It prevents cross-contamination between samples and also helps to maintain a clean working environment for the safety of all field personnel involved, including the environment.

Decontamination is mainly achieved by rinsing with liquids which include: soap and/or detergent solutions, tap water, deionized water, and methanol. Equipment will be allowed to air dry after being cleaned or may be wiped dry with chemical free cloths or paper towels if immediate re-use is needed.

The frequency of equipment use, dictates that most decontamination be accomplished at each sampling site between collection points. Waste products produced by the decontamination procedures such as waste liquids, solids, rags, gloves, etc. will be collected and disposed of properly based on the nature of contamination. All cleaning materials and wastes should be stored in a central location so as to maintain control over the quantity of materials used and/or produced throughout the study.

2.0 Responsibilities

It is the primary responsibility of the site operations manager to assure that the proper decontamination procedures are followed and that all waste materials produced by decontamination are properly stored and disposed of.

It is the responsibility of the project safety officer to draft and enforce safety measures which provide the best protection for all persons involved directly with sampling and/or decontamination.

It is the responsibility of any subcontractors (i.e., drilling contractors) to follow the proper, designated decontamination procedures that are stated in their contracts and outlined in the Project Health and Safety Plan.

It is the responsibility of all personnel involved with sample collection or decontamination to maintain a clean working environment and to ensure that any contaminants are not negligently introduced to the environment.

ENSR SOP 7600, "Decontamination of Equipment"

CHAIN OF CUSTODY RECORD

Client/Project Name		Project Location	
Project No.		Field Logbook No.	
Sampler: (Signature)		Chain of Custody Tape No.	

Sample No./ Identification	Date	Time	Lab Sample Number	Type of Sample	ANALYSES	REMARKS

Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Date	Time
Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Date	Time
Relinquished by: (Signature)	Date	Time	Received for Laboratory: (Signature)	Date	Time
Sample Disposal Method:			Disposed of by: (Signature)	Date	Time

SAMPLE COLLECTOR

ERT - A Resource Engineering Company
696 Virginia Road
Concord, MA 01742
617-369-8910

ANALYTICAL LABORATORY

ENSR

No. 1663

1974-3 84

Figure 1

4.15 Upon receipt of the samples, the analytical laboratory will open the cooler or shipping container and will sign "received by laboratory" on each chain of custody form. The laboratory will verify that the chain of custody tape has not been broken previously and that the chain of custody tape number corresponds with the number on the chain of custody record. The analytical laboratory will then forward the back copy of the chain of custody record to the sample collector to indicate that sample transmittal is complete.

5.0 Documentation

As discussed in Section 4.0 the documentation for supporting the sample packaging and shipping will consist of chain of custody records and shipper's records. In addition a description of sample packaging procedures will be written in the field log book. All documentation will be retained in the project files following project completion.

4.8 To complete the chain of custody form enter the type of analysis required for each sample, by container, under the "ANALYSES" section. Under the specific analysis enter the quantity/volume of sample collected for each corresponding analysis.

If shipping the samples where travel by air or other public transportation is to be undertaken, sign the chain of custody record thereby relinquishing custody of the samples. Relinquishing custody should only be performed when directly transmitting custody to a receiving party or when transmitting to a shipper for subsequent receipt by the analytical laboratory. Shippers should not be asked to sign chain of custody records.

4.9 Remove the last copy from the chain of custody record and retain with other field notes. Place the original and remaining copies in a zip-lock type plastic bag and place the bag on the top of the contents within the cooler or shipping container.

4.10 Close the top or lid of the cooler or shipping container and with another person rotate/shake the container to verify that the contents are packed so that they do not move. Improve the packaging if needed and reclose.

When transporting samples by automobile to the laboratory, and where periodic changes of ice are required, the cooler should only be temporarily closed so that reopening is simple. In these cases, chain of custody will be maintained by the person transporting the sample and chain of custody tape need not be used. If the cooler is to be left unattended, then chain of custody procedures should be enacted.

4.11 Place the chain of custody tape at two different locations on the cooler or container lid and overlap with transparent packaging tape. For coolers with hinged covers, if the hinges are attached with screws, chain of custody tape should also be used on the hinge side.

4.12 Packaging tape should be placed entirely around the sample shipment containers. A minimum of one to two full wraps of packaging tape will be placed at at least two places on the cooler. Shake the cooler again to verify that the sample containers are well packed.

4.13 If shipment is required, transport the cooler to an overnight express package terminal or arrange for pickup. Obtain copies of all shipment records as provided by the shipper.

4.14 If the samples are to travel as luggage, check with regular baggage.

The following information must accompany all samples and will be entered on a sample specific basis on chain of custody records:

- sample collector's name, mailing address and telephone number,
- analytical laboratory's name, mailing address and telephone number,
- quantity of sample,
- date of shipment,
- description of sample, and

in addition, all samples must be packaged so that they do not leak, spill or vaporize.

4.0 General Methods

4.1 Place plastic bubble wrap matting over the base and bottom corners of each cooler or shipping container as needed to manifest each sample.

4.2 Obtain a chain of custody record as shown in Figure 1 and enter all the appropriate information as discussed in Section 3.0 of this SOP. Chain of custody records will include complete information for each sample. One or more chain of custody records shall be completed for each cooler or shipping container as needed to manifest each sample.

4.3 Wrap each sample bottle individually and place standing upright on the base of the appropriate cooler, taking care to leave room for some packing material and ice or equivalent. Rubber bands or tape should be used to secure wrapping, completely around each sample bottle.

4.4 Place additional bubble wrap and/or styrofoam pellet packing material throughout the voids between sample containers within each cooler.

4.5 Place ice or cold packs in heavy duty zip-lock type plastic bags, close the bags, and distribute such packages over the top of the samples.

4.6 Add additional bubble wrap/styrofoam pellets or other packing materials to fill the balance of the cooler or container.

4.7 Obtain two pieces of chain of custody tape as shown in Figure 2 and enter the custody tape numbers in the appropriate place on the chain of custody form. Sign and date the chain of custody tape.

1.0 Applicability

This Standard Operating Procedure (SOP) is concerned with procedures associated with the packaging and shipment of samples. Two general categories of samples exist: environmental samples consisting of air, water and soil; and waste samples which include non-hazardous solid wastes and hazardous wastes as defined by 40 CFR Part 261.

2.0 Responsibilities

It is the responsibility of the project manager to assure that the proper packaging and shipping techniques are utilized for each project. The site operations manager shall be responsible for the enactment and completion of the packaging and shipping requirements outlined in the project specific sampling plan. The site operations manager shall be responsible to research, identify and follow all applicable U.S. Department of Transportation (DOT) regulations regarding shipment of materials classified as waste.

3.0 General Method

The objective of sample packaging and shipping protocol is to identify standard procedures which will minimize the potential for sample spillage or leakage and maintain field sampling program compliance with U.S. EPA and U.S. DOT regulations.

The extent and nature of sample containerization will be governed by the type of sample, and the most reasonable projection of the sample's hazardous nature and constituents. The EPA regulations (40 CFR Section 261.4(d)) specify that samples of solid waste, water, soil or air, collected for the sole purpose of testing, are exempt from regulation under the Resource Conservation and Recovery Act (RCRA) when all of the following conditions are applicable:

A. Samples are being transported to a laboratory for analysis;
B. Samples are being transported to the collector from the laboratory after analysis;
C. Samples are being stored (1) by the collector prior to shipment for analyses, (2) by the analytical laboratory prior to analyses, (3) by the analytical laboratory after testing but prior to return of sample to the collector or pending the conclusion of a court case.

Qualification for categories A and B above require that sample collectors comply with U.S. DOT and U.S. Postal Service (USPS) regulations or comply with the following items if U.S. DOT and USPS regulations are found not to apply: